EVALUATION OF RADIOLOGICAL FINDINGS AND OUTCOMES IN PATIENTS UNDERGOING BRONCHIAL ARTERY EMBOLIZATION

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DECLARATION BY THE CANDIDATE

I hereby declare that the thesis entitled "**EVALUATION OF RADIOLOGICAL FINDINGS AND OUTCOMES IN PATIENTS UNDERGOING BRONCHIAL ARTERY EMBOLIZATION**" submitted towards partial fulfillment of the requirements for the award of **MD in RADIODIAGNOSIS** degree to BFUHS is a compilation of original work carried out by me under the supervision of **Dr Siddharth Prakash**, Associate Professor, Department of Radiodiagnosis, **Dr Kamini Gupta**, Professor, Department of Radiodiagnosis and **Dr. Akashdeep Singh**, Professor, Department of Pulmonary Medicine. No part of this thesis has formed the basis for the award of any degree previously.

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Dedicated

to

my Family

&

Teachers

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Dr. Baljit Kaur

ABBREVIATIONS

CT	Compueted Tomography
MDCT	Multidetector Compueted Tomography
DSA	Digital Subtraction Angiography
BAE	Bronchial Artery Embolization
ICBAT	Intercostobronchial Artery Trunk
CBT	Common Bronchial Trunk
CPA	Chronic Pulmonary Aspergillosis
ABPA	Allergic Bronchopulmonary Aspergillosis
TB	Tubercular
PVA	Polyvinyl Alcohol

ABSTRACT

Introduction: Hemoptysisdue to various etiologies,especially if massive, is a life threatening respiratory emergency. Bronchial Artery Embolization (BAE) is a life saving and minimally invasive interventional radiological technique and is first line treatment for massive hemoptysisas ninety nine percent of massive hemoptysis originates from bronchial arteries rather than pulmonary circulation. Even the most compromised patients can be successfully managed with BAE as first-line treatment for hemorrhage as well as providing a bridge to more definitive medical or non-emergent surgical intervention focused upon the etiology of the hemorrhage.

Aims & Objectives: To evaluate the radiological findings and outcomes in patients undergoing Bronchial Artery Embolisation(BAE).

Materials and methods: Thirty patients (>18 years of age) who presented with hemoptysis at DMCH, Ludhiana& referred to interventional radiologist for BAE during the time period between from 15th Nov. 2019- 15th May 2021 were enrolled in the study . They were investigated by chest x rays, CT chest/ CT angiography (wherever possible) to look for cause of hemoptysis and underwent bronchial Artery Embolization. The demographic profile, etiology of massive hemoptysis, duration of underlying disease, pre procedure radiological findings and post-procedure follow up recorded as per designed proforma.

Results: Out of 30 patients who underwent BAE, immediate control of hemoptysis was achieved in n=26; 86.7% patients and in n=4; 13.3% patients recurrent hemoptysis seen. The most common cause of hemoptysis was pulmonary tuberculosis (n=18 ; 60%), either active (n=9; 30%) or sequalae of old treated pulmonary tuberculosis (n=9; 30%).The major cause of recurrent hemoptysis in n=3/4 patients was fibrocystic/ fibrobronchiectatic changes secondary to pulmonary tuberculosis with chronic pulmonary tubercular sequalae in n=2/4 and active bronchopneumonia in n=1/4 patients

Conclusion: BAE is life saving and minimally invasive interventional radiological technique and has become a widely accepted, first line treatment option in the management of patients with haemoptysis. MDCT angiography should be performed prior to BAE, which helps us to make diagnosis, identify the culprit vessels as well as provide a roadmap for management of hemoptysis. With the current use of particulate embolic agents greater than 200 mm and modern microcatheters or microguide wires, non target embolization, thus the risk of major complications like spinal cord ischemia are quite rare.

Keywords: Hemoptysis, Bronchial artery embolization, Intervention, CT Angiography, Radiology.

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INTRODUCTION

Hemoptysis is expectoration of blood from lower respiratory tract.[1] Massive hemoptysis (>200ml) or any volume of blood that can lead to airway obstruction or aspiration is a life threatening respiratory emergency

In many studies, the estimated mortality rate due to massive hemoptysis ranges between 6.5 to 38%, even with advanced modern supportive care & interventions. Also it can reach> 50% if not treated appropriately.[2-8]

Etiologies

The various etiologies of massive hemoptysis include tuberculosis, bronchiectasis (both tubercular & non tubercular and even post COVID fibrosis related), fungal infection (aspergilloma,mycetoma and allergic bronchopulmonary aspergillosis), cystic fibrosis, arteriovenous malformations, lung carcinomas and cryptogenic hemoptysis (i.e cases where definite diagnosis cannot be reached).[2,3]

Tuberculosis either active or from sequalae of prior infection being the most common cause of hemoptysis especially in developing countries like India.[9]

The anatomic source of hemoptysis is usually bronchial arteries in 99% cases and pulmonary arteries in 1% cases. Lungs have dual blood supply ,99% from pulmonary arteries & 1% from bronchial arteries. These receive only 1% of the cardiac outputand are source of systemic blood supply to the tracheobronchial tree, esophagus , visceral pleura & vasa vasorum of thoracic aorta , pulmonary arteries, veins & nerves.[10,11]

VARIOUS IMAGING MODALITIES AND MANAGEMENT

Chest X rays – These are readily available & quick to perform. In most instances either they are normal or show lung parenchymal abnormalities like consolidations, bronchiectasis, cavities, mass or nodules. Howeverthese are not helpful in localization of bronchial arteries or potential collaterals if BAE is warranted.[2,10]

In cross-sectional images, bronchial arteries are best depicted at multidetector CT of chest/ CT chest angiography performed with high volume (eg. 80-100 ml of standard nonionic intravenous contrast agent) and high flow (eg. 3-4 ml/sec injection rate) contrast agent administration. Images should be acquired during the phase of maximal descending thoracic aortic enhancement which is determined by using bolus tracking software.[12]

Angiography and bronchial artery embolization (BAE) are important modalities allowing for rapid diagnosis and treatment in hemoptysis

ANATOMY OF BRONCHIAL ARTERIES ON IMAGING

Bronchial arteries can be orthoptic or ectopic in origin. Orthoptic origin is called when they originate directly from proximal descending thoracic aorta between superior end plate of D5 to inferior end plate of D6 vertebral bodies with most commonly used landmark being 1 cm either above or below the left main stem bronchus on angiography.[13]

Ectopic origin is called when these originate elsewhere in aorta or from other vasculature, common sites being inferior aortic arch, distal descending thoracic aorta, internal mammary artery, subclavian artery, thyrocervical trunk, brachiocephalic trunk and even coronaries arteries.[10,14-16] Left bronchial arteries usually arise directly from aorta while right bronchial arteries either arise from intercostobronchial artery trunk (ICBAT) or common bronchial trunk (CBT) from which originates both the bronchial arteries.[17]

There are four common types of pattern of origin of bronchial arteries. Type 1, the most common pattern, consists of one right bronchial artery arising from ICBAT &two left bronchial arteries. Type 2, consists of one right bronchial artery arising from ICBAT & one left bronchial artery. Type 3, consists of two bronchial.

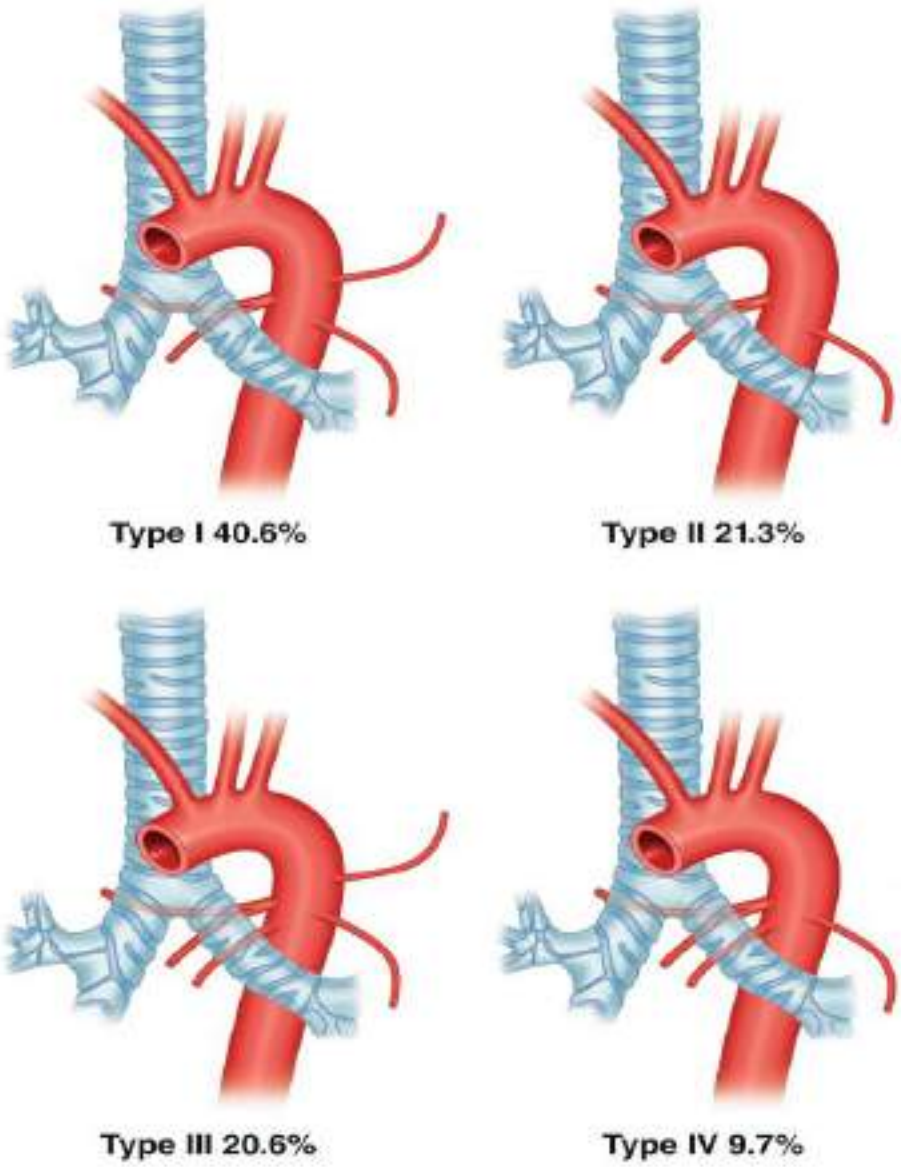

Figure 1 Types of pattern/variants of origin of bronchial arteries as described by Cauldwell.[18] Type I, most common pattern, with a single right intercostobronchial artery trunk and two left bronchial arteries, each having separate origin. Type II, has a single right intercostobronchial artery trunk, with only one left bronchial artery. Type III anatomy has a right intercostobronchial artery trunk and an additional right bronchial artery with its own origin, along with two left bronchial arteries. In Type IV anatomy, there are paired right bronchial arteries, one of which has an intercosto-bronchial artery trunk, and there is a solitary left bronchial artery

arteries on each side with one of the right bronchial artery arising from an ICBAT. Type 4, consists of two right bronchial arteries, one of which arises from ICBAT and one left bronchial artery.[19]

Bronchial arteries are high resistance vessels with low distensibility which on MDCT angiography, usually seen as small, thread like vascular channels.[14] During various acute or chronic inflammatory processes of lungs / thorax and in neoplastic conditions, due to releases of angiogenic factors, these get hypertrophied or dilated or become more tortuous to supply that diseased/ ischemic tissue of lung.[11,20] There even develop multiple collateral eg. from subclavian artery, thyrocervical trunk, internal mammary artery, intercostal arteries, lateral thoracic & dorsal scapular artery etc. to supply the affected lung parenchyma.[12]

Bronchial arteries are considered abnormally dilated when these are > 2mm in diameter at the site of origin, > 0.5mm when enter pulmonary hilum and have extensively tortuous mediastinal course.[21]

Bronchial Artery Embolization

BAE is life saving and minimally invasive interventional radiological technique. It was first performed in 1973 by Remy et al, and has become a widely accepted treatment option in the management of patients with haemoptysis. It is the first line treatment for massive hemoptysis where surgical interventions are contraindicated.[22,23] The aim of embolization is to reduce the perfusion pressure to fragile vessels in affected areas of lung by occluding the systemic arterial inflow. It is important to embolize as close to the site of the abnormal bronchopulmonary anastomoses as possible, in order to prevent their recurrence from nonbronchial systemic collateral vessels.[1]

TECHNIQUE OF BAE

BAE is performed under Digital Subtraction Angiography (DSA) guidance. Vascular access is usually taken through a 5 French sheath placed into femoral artery usually right and 5 French catheter (Cobra, Simmons, type catheters) introduced over guidewire under DSA, to look for the origin as well as cannulation of the bronchial arteries and other potential systemic arteries. After selection bronchial artery is

opacified using iodinated contrast material to look for hypertrophied or tortuous bronchial arteries, shunting into the pulmonary vasculature, hypervascularity, aneurysm formation or extravasation of iodinated contrast which is an exceedingly rare finding.[10,24-26] Once an abnormal bronchial artery is identified, a microcatheter is introduced coaxially through the initially placed 5 French catheter and advanced distally to ensure stability & avoid potential anterior medullary branches arising proximally off the bronchial arteries or ICBAT. A number of embolic materials are available for BAE for example Gel foam, glue (nbutyl-2-cyanoacrylate), PVA (Polyvinyl Alcohol). PVA is nonabsorbable particulate agent available in a variety of particulate sizes, with 355 to 500 micrometer in diameter particles are the most frequently used worldwideas the particles of smaller sizes can cause necrosis of the bronchial arteries or lead to shunting into the pulmonary circulation via occult anastomoses.[25,27] It is suspended in iodinated contrast under direct fluoroscopic guidance in order to prevent reflux or non-target embolizationMetal coils are generally avoided because they tend to occlude more proximal vessels and preclude further embolization if bleeding recurs. However, they are used to occlude pulmonary artery aneurysms and pulmonary Arteriovenous Malformations.[28] The embolization is continued until there is near stasis of particleor complete occlusion of the target vessel.

POST BAE COMPLICATIONS

Post procedure complications which are more common includerecurrence of hemoptysis, chest pain and dysphagia which occur with selective (versus super selective) embolization, usually within the first week following the procedure. These symptoms are due to the interruption of the blood supply to the posterior mediastinum and mid-portion of the oesophagus. This is less common when distal super selective catheterisation is used.**[1,29,30]** Recurrence of hemoptysis Is common, especially in patients with chronic pulmonary aspergillosis (CPA). Cavitating lung lesions, nonbronchial systemic artery collaterals and systemic-to-pulmonary venous shunts appeared more commonly among patients who had recurrence of hemoptysis Definitive treatment

for CPA following successful BAE should be considered to ensure the long-term success of the embolization in these patients.[31]

Few rare complications include Spinal cord injury, subintimal dissection of the aorta, transverse myelitis [17], arterial puncture site injuries and anterior cord syndrome.[32] Thus an angiograms must be carefully examined for the presence of medullary arteries which reinforce the anterior spinal artery & classically have a hairpin configuration and can arise from the bronchial or intercostal arteries.[10] The greater anterior medullary artery or the artery of Adamkiewicz, arises at the T9-T12 level in 75% of cases.

AIMS AND OBJECTIVES

To evaluate the radiological findings and outcomes in patients undergoing Bronchial Artery Embolisation (BAE)

REVIEW OF LITERATURE

Rabkin et al,(1987)[33] evaluated 306 patients with acute pulmonary hemorrhage by bronchial arteriography and treated them with transcatheter embolization, of which 120 patients were with massive hemoptysis having volumes exceeding 500 ml/day and the majority (n = 225) were treated during peak hemorrhage. It was found that BAE controlled acute bleeding in 278 (91%), including 87.5% of those treated during peak hemorrhage. In 26 of 28 cases without initial response, the pulmonary artery was the source of bleeding. Recurrent bleeding, within 1-4 days, requiring surgery was observed in 39 patients with initially successful hemostasis. Of 158 patients who were treated without surgery, subsequent episodes of hemoptysis occurred in 36. Thus it was concluded that the combined methods of embolization may improve the efficacy of treatment of operable and inoperable patients with lung disease complicated by hemorrhage

Hayakawa et al(1992)[34] have reported two peak times of bleeding recurrence. The first is from 1 to 2 months after BAE, which may reflect incomplete embolization. The second peak for recurrence is from 1 to 2 years after the patient underwent embolization. This appears to reflect the recruitment of blood supply and revascularization due to underlying pulmonary inflammation or progression of the underlying disease

Knott-Craig and colleagues(1993)[5] retrospectively studied 120 patients with hemoptysis and found that the right lung was the source in 62% and the left lung in 38%, with the right upper lobe being the area that was most commonly affected.

Cremaschi et al (1993)[35] evaluated 209 patients From 1974 to 1990 who had been embolized for hemoptysis with different etiopathogeneses including bronchiectasis(46%), tuberculosis (31%), cystic fibrosis (16%), lung cancer (4%), and aspergillosis (3%). In 98% of the patients hemoptysis was controlled in the first twenty-four hours, the other 2% in the following forty eight hours. In 16% relapses occurred within the first year; 27 patients needed reembolization (15 patients twice, 11 patients three times, 1 patient five times)

Ramakantan et al (1996)[36] evaluated the results of BAE done between 1988 and 1994, on 140 patients with tuberculosis (125 men and 15 women; with mean age of 31.5 years) who presented with massive hemoptysis. Almost complete control of hemoptysis was achieved in 102 patients. Of the remaining 38 patients had notable amount of bleeding after the procedure, of which 29 were treated successfully with conservative management and nine underwent re-embolization. Seven patients who underwent re-embolization had recurrent bleeding; four of these patients underwent successful surgery, and three died of aspiration. Two patients developed transient paraparesis 6 hours after the procedure. Nine patients reported transient referred pain to the ipsilateral orbit/forehead during injection of the gelatin sponge and one patient had transient dysphagia as complication.

Hirshberg et al(1997)[4] studied the etiology, evaluation, and outcome of 208 patients with hemoptysis in a tertiary referral hospital. They found that the most common causes of hemoptysis included bronchiectasis (20%), lung cancer (19%), bronchitis (18%), and pneumonia (16%).

Tanaka and colleagues (1997)[37] selected 47 patients with hemoptysis. Superselective embolotherapy was performed using a microcatheter inserted into the bronchial artery beyond the spinal or mediastinal branches in 22 patients, where initial hemoptysis control rates were 96%. In the remaining 25 patients, non-superselective embolization was performed near the origin of the bronchial artery with initial hemoptysis control rates of 88%. There were no significant differences between the two groups in the initial or cumulative control of hemoptysis. Cumulative hemoptysis control rates of the superselective and nonsuperselective groups were 80% and 67% at 6 months, 79% and 56% at 1 and 2 years, and 79% and 48% at 3 years, respectively (not significant; generalized Wilcoxon test). But spinal infarction, as a major complication occurred in the nonsuperselective group. There were no neurologic complications in the superselective

group. ThusSuperselective embolization is safer and more effective way to control hemoptysis than the nonsuperselective method

Brinson *et al(1998)*[38] in regards to cystic fibrosis, published the most comprehensive review to date by evaluating 18 patients who underwent a total of 36 BAE procedures. The overall efficacy of the BAE for initial control of hemoptysis was 75% after one session

Mal et al,(1999)[6] reported that among 56 patients undergoing attempted embolization procedures for hemoptysis, the immediate control of bleeding was achieved in 43 of 56 patients (77%). 4 patients who died from causes other than hemoptysis or who underwent surgery were excluded from follow-up , In the 39 remaining patients, on follow up during first 30 days, after BAE, a complete cessation of hemoptysis was observed in 32 patients. A remission was noted in 28 of the 29 patients followed up between 1 and 3 months after BAE. Long-term control of bleeding was achieved in 25 of the initial 56 patients (45%) followed up beyond 3 months after BAE (median follow-up of 13 months; range, 3 to 76 months). Overall, complications of BAE consisted of two episodes of mediastinal hematoma and three episodes of neurologic damage, two of which improved without permanent sequelae. Thus it was concluded that BAE may result in immediate as well as long-term control of life-threatening hemoptysis but that complications are not unusual**.**

Saluja et al (2000)[28] have suggested that metal coils should not be used for BAE as they cause proximal occlusion and do not allow for repeat embolization if necessary or bleeding recurs. However, they are used to occlude pulmonary artery aneurysms and pulmonary Arteriovenous Malformations.

Peter Corr et al(2006)[39] conducted study on 12 patients presenting with severe hemoptysis & in whom a radiological diagnosis of pulmonary aspergilloma was made on chest radiographs and/or computed tomography of the chest. They were subjected to bronchial and systemic arteriography and embolization using triacryl microspheres. Out of 12 in 11 patients hemoptysis stopped within 24 hr after the procedure with no recurrence over the next 1 month. In 1

patient hemoptysis persisted and an upper lobe lobectomy was performed. Thus it was concluded that embolization of bronchial and systemic arteries is an effective method for treating acute severe hemoptysis from intracavitary aspergillomas, allowing the patient time to recover for definitive surgical management.

Lee et al.(2008)[40] demonstrated a significant association between active tuberculosis and recurrence after BAE, by conducting retrospective study on two groups of patients. For all the 32 patients, of which one group having 19 patients with acute major haemoptysis and 13 patients with chronic recurrent bleeding, with follow-up data available. Overall immediate control was attained following 99% of the procedures with overall recurrence rate of 36% (26% in the acute and 47% in chronic group). and a complication rate of 13%. All complications were mild and self-limiting. No statistically significant difference in recurrence probability between the two groups was observed (P=0.24). The presence of active pulmonary tuberculosis was found to be associated with increased risk of recurrence (P=0.005)

Prasad et al(2009)[9] in their study including 476 patients with hemoptysis, of which 352 patients were males and 124 were females, observed that pulmonary tuberculosis was the leading cause of hemoptysis with 377 (79.2%) patients in the pulmonary tuberculosis group with majority of the patients having moderate hemoptysis, 25 (5.7%) in the neoplasm group, 19 (4.0%) in the chronic bronchitis group, 18 (3.8%) in the bronchiectasis group, and 35 (7.3%) patients with hemoptysis due to other causes.

Singhal et al(2011)[30] also reported aspergilloma as the cause of recurrence of haemoptysis in one patient during their one-year followup. Thus, aspergilloma remains the commonest cause of recurrence of haemoptysis after embolisation and requires repeated embolisation or definitive surgical management.

Anuradha et al (2012)[41] evaluated the results of BAE in 58 patients with post-TB sequelae. 58 patients underwent 64 bronchial artery embolization for massive hemoptysis due to tuberculosis 25 patients presented with acute massive hemoptysis and 33 presented with

chronic recurrent hemoptysis. The median follow-up period was 432 days. Twenty-seven patients had recurrence after a median period of 110 days after the procedure. The hemoptysis control rate was 93% at 2 weeks, 86% at one month, 79.5% at 3 months, 63% at6 months. Six patients underwent repeat procedures. Chest pain was the most common procedure-related complication (n=20, 34.5%); there was no spinal cord complication or mortality. Lung cavities, nonbronchial systemic artery collaterals and systemicto-pulmonary venous shunts were more common in those who experienced recurrence. Post-procedure complications: chest pain in 20 (34.5%), dysphagia in 3 (5%), transient dissection of bronchial and intercostalarteriesin 2 (3.4%) patients.

Kervancioglu S, et al (2015) [42] Angiographic findings show that whatever the underlying cause for cryptogenic hemoptysis, it involves the lung(s) in a diffuse manner. BAE is an effective and reliable treatment option for cryptogenic hemoptysis, with excellent short-term and long-term results**.**

Shin B, Koh W-J, Shin SW, Jeong B-H, Park HY, Suh GY, et al. (2016) [31] BAE is a safe and effective procedure for the management of life-threatening hemoptysis in patients with CPA. However, recurrence of hemoptysis was common, especially in patients with CPA. Therefore, definitive treatment for CPA following successful BAE should be considered to ensure the long-term success of the embolization in these patients

Mishra et al(2018)[43] evaluated 52 patients with hemoptysis and had a median follow up of 35 days. He showed Tuberculosis and its sequel (bronchiectasis and chronic fibrotic changes) as the commonest etiology (65%). The BAE showed high short term efficacy (92%) in stopping the hemoptysis with a relatively low complication rate especially of major complications such as spinal cord ischemia (1.9%). BAE should be tried in all patients presenting with uncontrollable or massive hemoptysis not getting relief by conservative management alone.

MATERIALS AND METHODS

This case series analysis was conducted in the Department of Radiodiagnosis, Dayanand Medical College and Hospital, Ludhiana, Punjab for one and half years from 15th Nov. 2019- 15th May 2021 (including followup for upto 3 months). The adult patients (>18 years of age) presented with hemoptysis in Dayanand Medical College & Hospital, Ludhiana and investigated by chest x rays, CT chest and CT angiography (wherever possible) to look for cause of hemoptysis and referred to interventional radiologist in department of radiodiagnosis, for Bronchial Artery Embolization are included. The demographic profile, etiology of hemoptysis, duration of underlying disease, pre procedure radiological findings and post-procedure follow up has been recorded as per designed proforma.

Source of Data

The study was conducted on patients who underwent BAE in Intervention radiology department of department of radiodiagnosis, Dayanand Medical College & Hospital, Ludhiana. Their preprocedural radiological investigations during this time frame studied and followed up to know clinical outcomes, etiology of hemoptysis (if possible) and post procedure complications of patients after BAE.

METHOD OF COLLECTION OF DATA

This case series analysis was conducted in the Department of Radiodiagnosis, Dayanand Medical College and Hospital, Ludhiana, Punjab for one and half years from 15th Nov. 2019- 15th May 2021 (including followup). The adult patients (>18 years of age) presented with hemoptysis in Dayanand Medical College & Hospital, Ludhiana and investigated by chest x rays, CT chest and CT angiography to look for cause of hemoptysis and referred to interventional radiologist in department of radiodiagnosis,for Bronchial Artery Embolization were included. The demographic profile, etiology of hemoptysis, duration of underlying disease, pre procedure radiological findings and post-procedure followed up as per designed proforma. Details of past medical history& age were taken into consideration during follow up.

Inclusion criteria: Hemoptysis

Exclusion Criteria:

1. Consent not available
2. Contrast allergy
3. Coagulation disorder.
4.Diffuse alveolar haemorrhage.
5.Vasculitis

Duration of study: One and half years from 15th Nov. 2019- 15th May2021 (including followup)

Outcome: Immediate and late (3 month) outcome/success of BAE.

Statistical analysis: Data was described in terms of range; mean±standard deviation (± SD), frequencies (number of cases) and relative frequencies (percentages) as appropriate. All statistical calculations were done using SPSS (Statistical Package for the Social Science) SPSS21 version statistical program for Microsoft Windows.

OBSERVATION AND RESULTS

1. DEMOGRAPHIC AND CLINICAL DATA

a) Age distribution of patients

The study was conducted on 30 patients presented with hemoptysis. The age range of patients was 18 to 89 years with mean age of 48.5 years. Maximum patients in our study were between 41 to 60 years (n=16; 53.3%)

Table 1: Distribution of patients according to age

Age	No. of cases	Percentage
< 40	9	30.0%
41-60	16	53.3%
> 40	5	16.7%
Total	30	100.0%

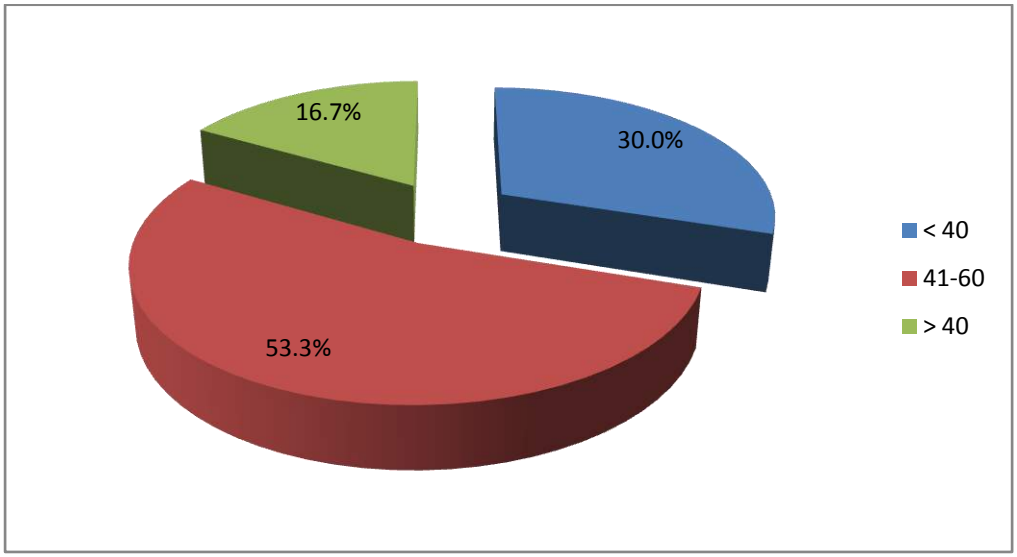

Figure 2: Distribution of patients according to age

b) Gender distribution of patients

The maximum number of patients in our study were males (n=24; 80%) with males: females ratio of 4:1

Table 2: Distribution of patients according to gender

Gender	No. of cases	Percentage
F	6	20.0%
M	24	80.0%
Total	30	100.0%

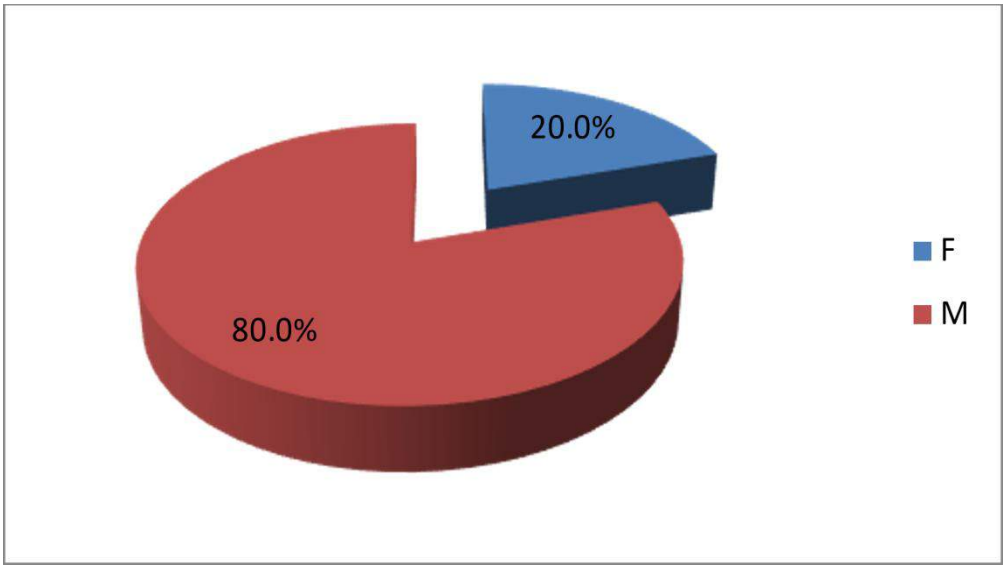

Figure 3: Distribution of patients according to gender

c) Clinical symptoms

Out of 30 patients n=25; 83.3% were presented with massive hemoptysis and remaining n=5; 16.7% were presented with mild recurrent hemoptysis

Table 3: Distribution of patients according to clinical symptoms

Hemoptysis	No. of cases	Percentage
massive	25	83.3%
Mild recurrent	5	16.7%
Total	30	100.0%

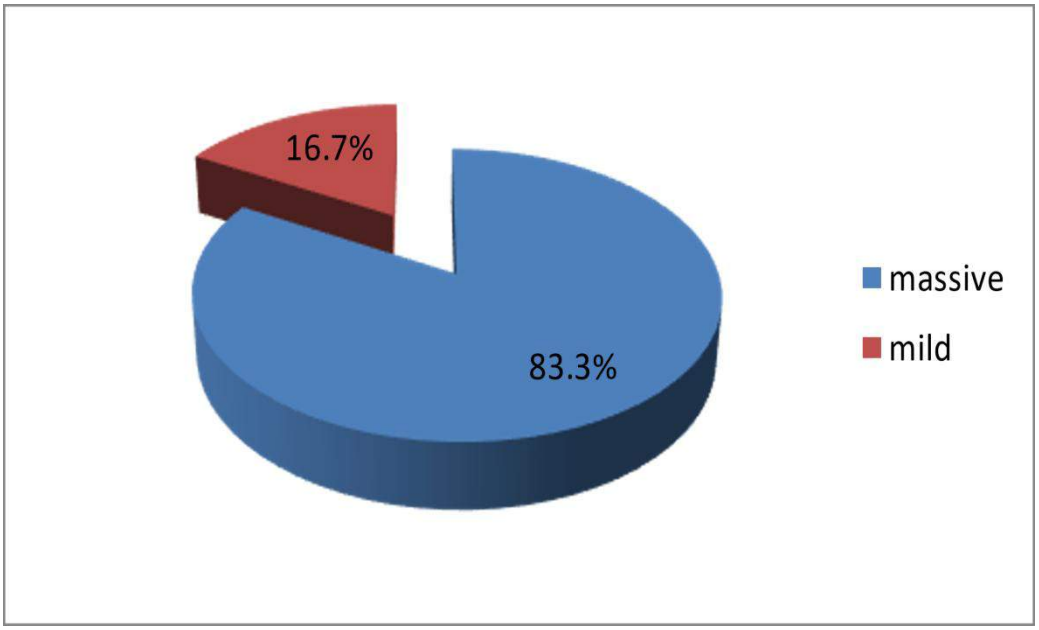

Figure 4: Distribution of patients according to clinical symptoms

d) Etiology/Cause of hemoptysis

In our study, the most common cause of hemoptysis was pulmonary tuberculosis (n=18; 60%), either active (n=9; 30%) or sequalae of old treated pulmonary tuberculosis (n=9; 30%). Active infection other than tuberculosis was found in 10% (n=3) and Post COVID fibrosis as the cause in 10% (n=3) patients.

Table 4: Distribution of patients according to etiology

Etiology	No. of cases	Percentage
Active tuberculosis	9	30.0%
Post tubercular sequelae	9	30.0%
Active infectious aetiology other than tuberculosis	3	10.0%
Bronchial Asthma with ABPA	2	6.7%
Post COVID fibrosis	3	10.0%
Pseudoaneurysms	2	6.7%
Squamous cell carcinoma of lung	1	3.3%
Unknown Aetiology	1	3.3%
Total	30	100.0%

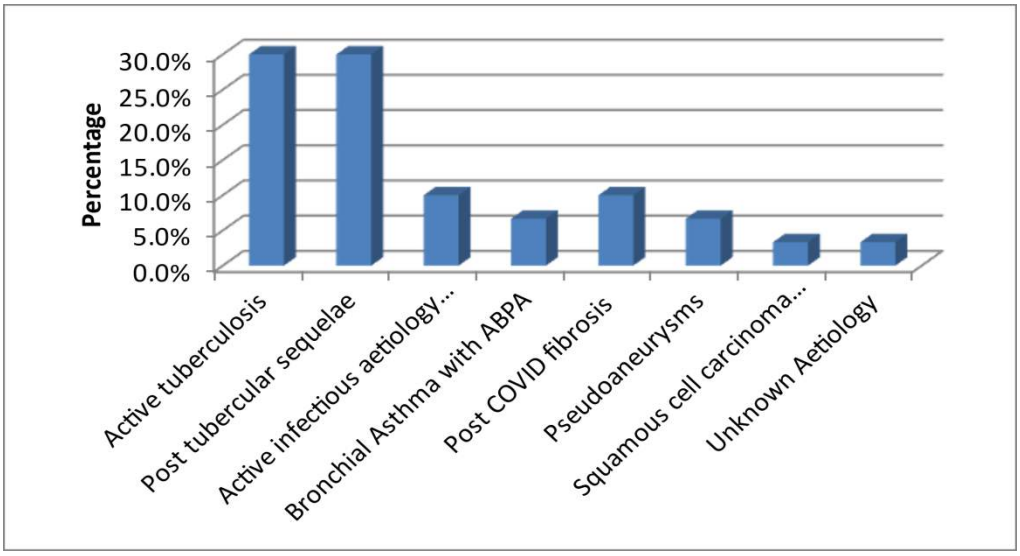

Figure 5: Distribution of patients according to etiology

B) Radiological findings

a) X-Rays findings

On pre-embolization radiographs, Consolidation was seen in 46.7% (n=14) and bronchiectasis in 40% (n=12) cases. Nodular opacities were seen in 50% (n=15), fibrocystic/fibrocavitory changes in 26.7%(n=8) and reticulonodular opacites in 36.7% (n=11) patients.

Table 5: Distribution of patients according to X rays findings

X-ray findings (n=30)	No. of cases	Percentage
Consolidation	14	46.7%
Bronchiectasis	12	40.0%
Fibrocystic changes/ fibrocavitory changes	8	26.7%
Reticulonodular opacities	11	36.7%
Ground glass haze	1	3.3%
Nodular opacities/mass	15	50.0%
Miliary pattern	0	0.0%

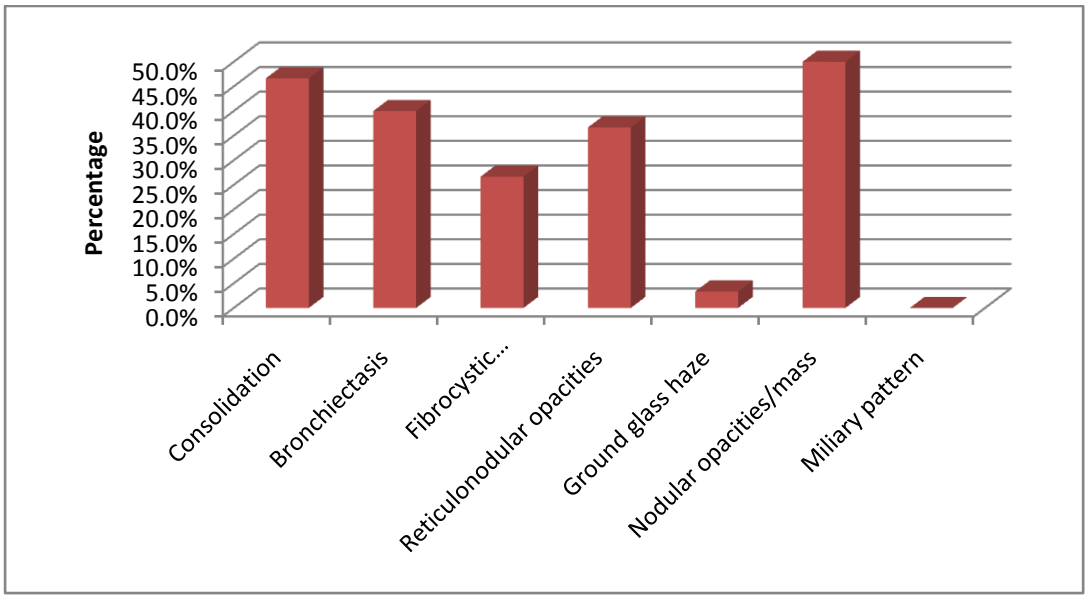

Figure 6: Distribution of patients according to X rays findings

b) CT Lung parenchymal findings

On pre-embolization, CECT chest, consolidation was seen in 73.3% (n=22) and bronchiectasis in 50% (n=15) cases. Cavitations were seen in 23.3% (n=7), ABPA in 6.6%(n=2), fibrocystic/fibronodular changes in 13.3%(n=4) and ground glass haze in 16.7% (n=5) patients

Table 6: Distribution of patients according to CT lung parenchymal findings

Parenchymal findings (n=30)	No. of cases	Percentage
Consolidation	22	73.3%
Bronchiectasis	15	50.0%
cavitation	7	23.3%
ABPA	2	6.7%
Diffuse alveolar damage/ground glass haze	5	16.7%
Fibrocystic changes/fibronodular changes	4	13.3%
Mediastinal lympnodes	25	83.3%
Miliary pattern	0	0.0%

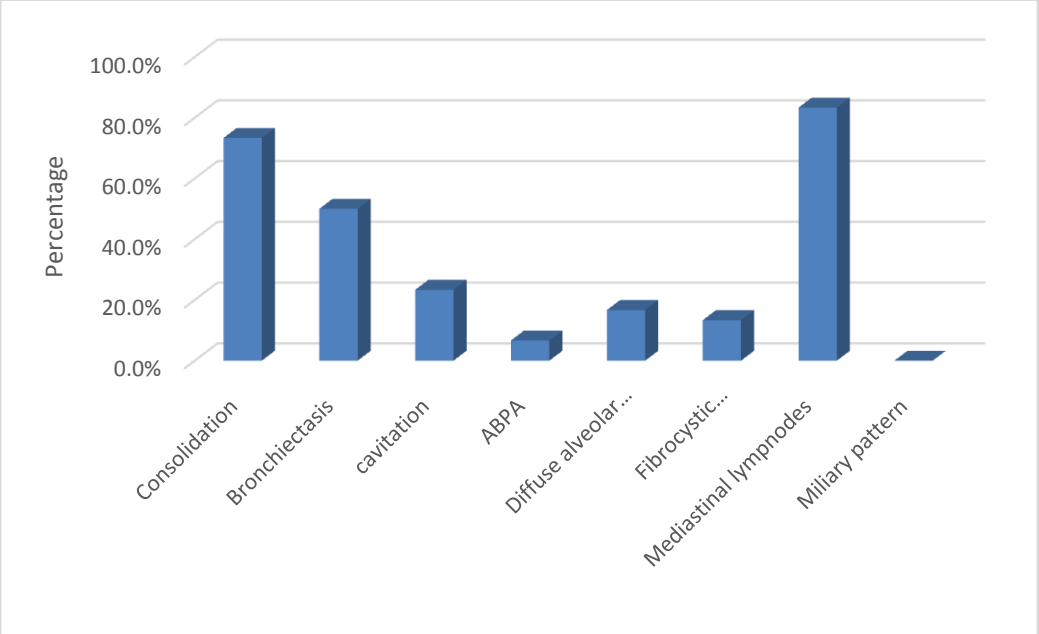

Figure7: Distribution of patients according to CT lung parenchymal findings

c) CT angiogram vascular findings

On pre-embolization, CT angiogram chest, bronchial arteries hypertrophy was found in 83.3%(n=25) and bronchial arteries tortuosity in 76.7%(n=23) patients. Arteriopulmonary shunting and active extravasation of I/V contrast found in none of the patients

Table 7: Distribution of patients according to CT angiogram findings

CT angiogram vascular findings (n=30)	No. of cases	Percentage
Bronchial artery hypertrophy	25	83.3%
Bronchial artery tortosity	23	76.7%
Arteriopulmonary shunting	0	0.0%
Active extravasation of contrast	0	0.0%

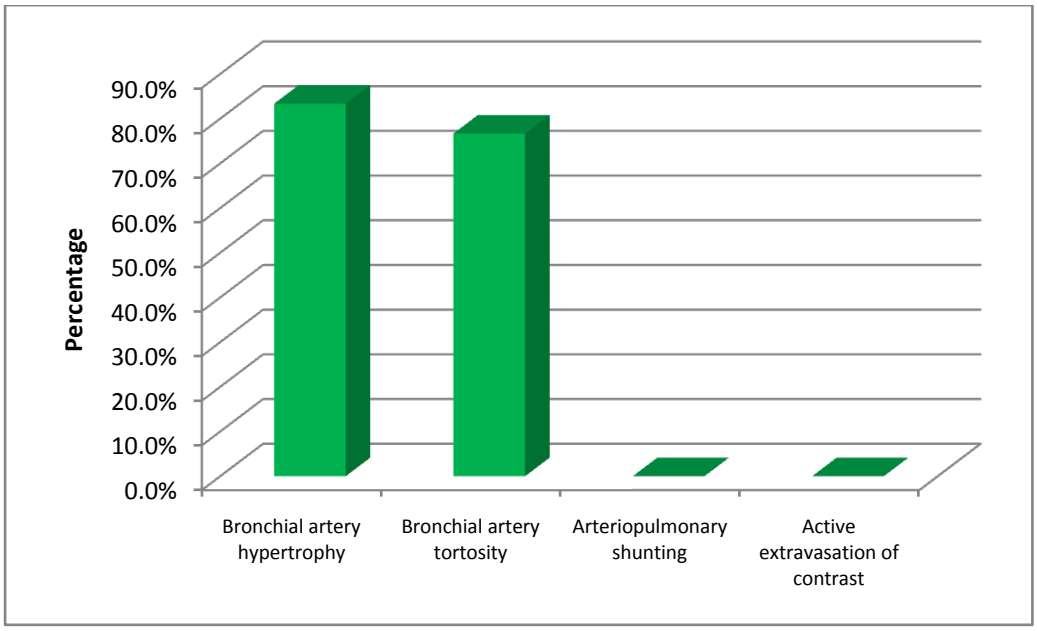

Figure 8: Distribution of patients according to CT angiogram findings

C) Cath lab/ DSA findings

a) Types of orthoptic bronchial arteries

In the current analysis, out of all the 39 orthoptic right bronchial arteries, 23 were seen originating from right ICBT, 10 from CBT and 6 directly from proximal descending thoracic aorta as single right bronchial artery, while single left bronchial artery was seen in 15 patients out of 30 who underwent BAE

Table 8: Distribution of patients according to orthoptic origin of bronchial arteries

Type of orthoptic bronchial arteries	No. of cases
Right single bronchial artery	6
Left single bronchial artery	15
Right ICBT	23
Common bronchial trunk	10

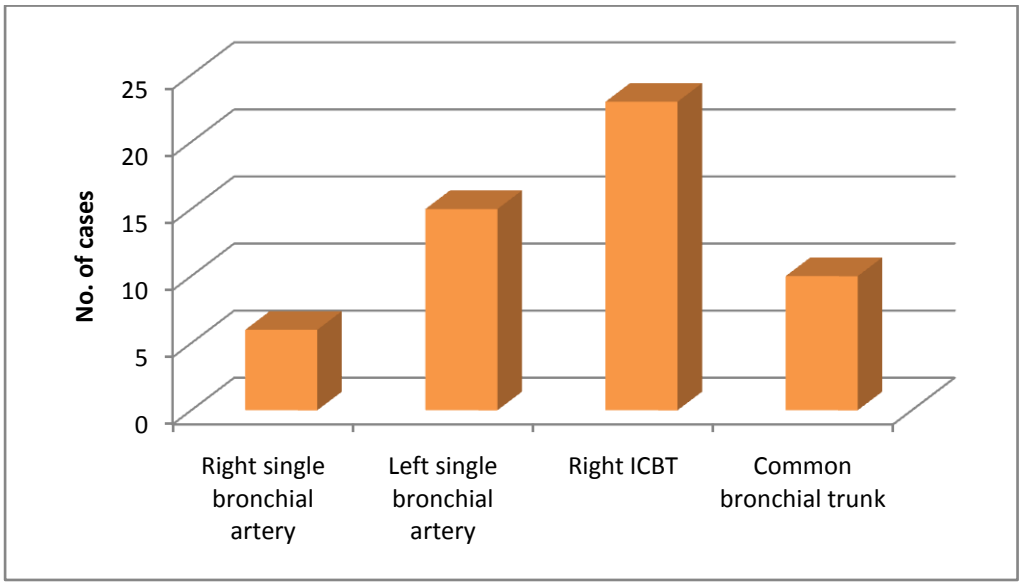

Figure 9: Distribution of patients according to orthoptic origin of bronchial arteries

b) Collaterals from systemic arteries

On pre-embolization, check angiogram, a total of 27 collaterals arteries were seen originating from intercostal arteries (n=9/27), both lateral thoracic arteries (right n = 2/27 ; left n=4/27), right thyrocervical trunk (n=2/27) , inferior arch of aorta (n=2/27), distal descending thoracic aorta (n=2/27) , both internal mammary arteries (right n=2/27 ; left n=3/27) and left dorsal scapular artery (n=1/27).

Table 9: Distribution of patients according to collaterals from systemic arteries

Collaterals from systemic arteries	No. of arteries
Inferior arch of aorta	2
Distal descending thoracic aorta	2
Right internal mammary artery	2
Left internal mammary artery	3
Intercostal arteries	9
left dorsal scapular artery	1
Right lateral thoracic artery	2
Leftlateral thoracic artery	4
Right thyrocervical artery	2

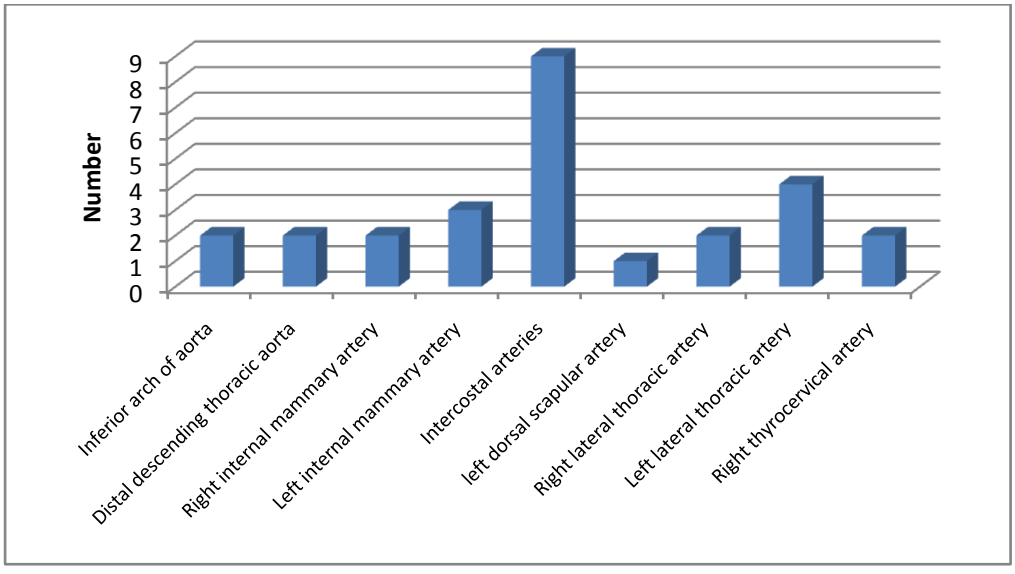

Figure 10: Distribution of patients according to collaterals from systemic arteries

c) Bronchial angiogram findings

On bronchial arteriogram under DSA, prior to BAE, arteriopulmonary shunting found in n=7/30 (23.3%) patients, pseudoaneurysm in n=2/30 (6.7% case) with frequency of bronchial artery hypertrophy & tortuosity remaining the same as that of MDCT angiography.

Table 10: Distribution of patients according to bronchial angiogram findings

Bronchial arteriogram (n=30)	No. of cases	Percentage
Bronchial artery hypertrophy	25	83.3%
Bronchial artery tortosity	23	76.7%
Arteriopulmonary shunting	7	23.3%
Pseudoaneurysms	2	6.7%
Active extravasation of contrast	0	0.0%

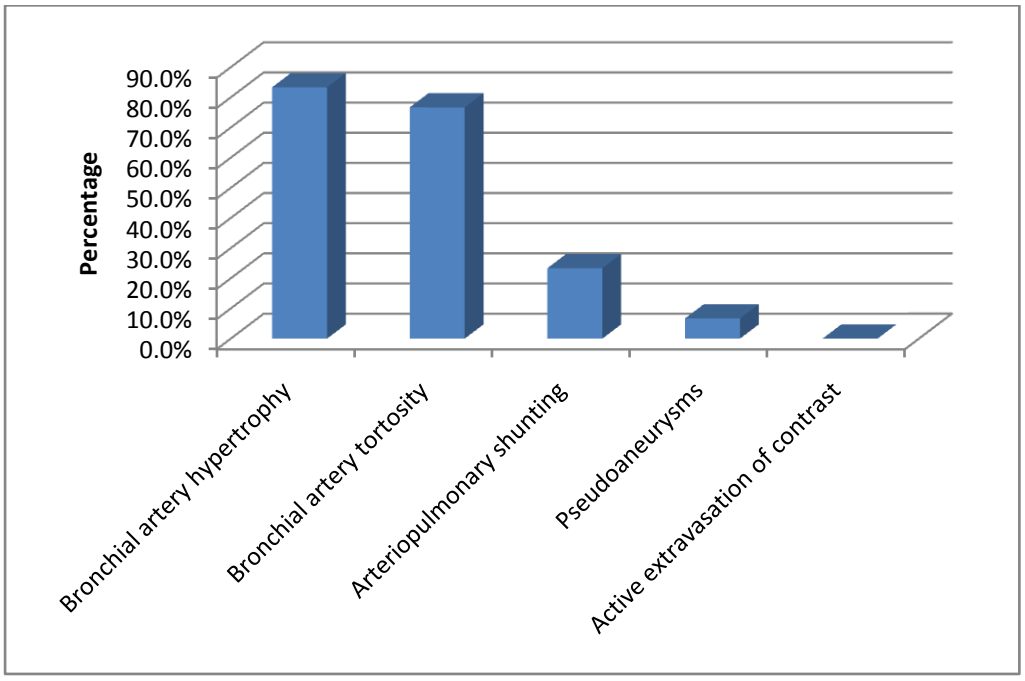

Figure 11: Distribution of patients according to bronchial angiogram findings

d) Vessels embolized

A total of 75 arteries were embolized with right ICBAT being the most common artery (n=19/75 ; 25.3%) followed by left orthoptic bronchial artery (n=14/75; 18.7%) , right orthoptic bronchial artery (n=12/75 ; 16%) , intercostal arteries (n=9/75; 12%), Common bronchial trunk (n=9/75; 12%), internal mammary artery, lateral thoracic artery, right thyrocervical trunk and dorsal scapular artery.

Table 11: Distribution of patients according to arteries embolized

vessels	No. of cases	Percentage
Right Intercostobronchial artery trunk	19	25.3%
Common bronchial trunk (CBT)	9	12.0%
Right orthoptic Bronchial artery	12	16.0%
Left orthoptic Bronchial artery	14	18.7%
Intercoastal arteries	9	12.0%
Internal mammary artery	5	6.7%
Lateral thoracic artery	4	5.3%
Dorsal Scapular artery	1	1.3%
Thyrocervical trunk	2	2.7%
Brachiocephalic artery branches	0	0.0%
Coronary artery	0	0.0%
Total arteries embolized	75	100.0%

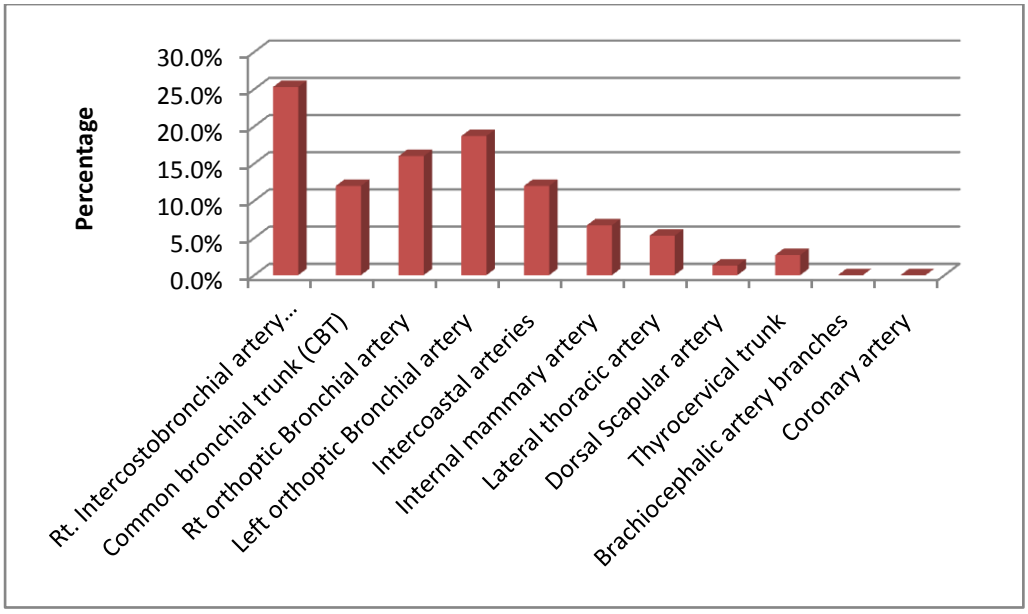

Figure 12: Distribution of patients according to arteries embolized

D) Post embolization complications

a) Recurrent hemoptysis

Out of 30 patients who underwent BAE, immediate control of hemoptysis was achieved in n=26; 86.7% patients and in n=4; 13.3% patients recurrent hemoptysis seen

Table 12: Distribution of patients according to recurrent hemoptysis

Recurrent hemoptysis	No. of cases	Percentage
No recurrent hemoptysis	26	86.7%
yes, after 1day	2	6.7%
yes, after 1month	1	3.3%
yes, after 3month	1	3.3%
Total	30	100.0%

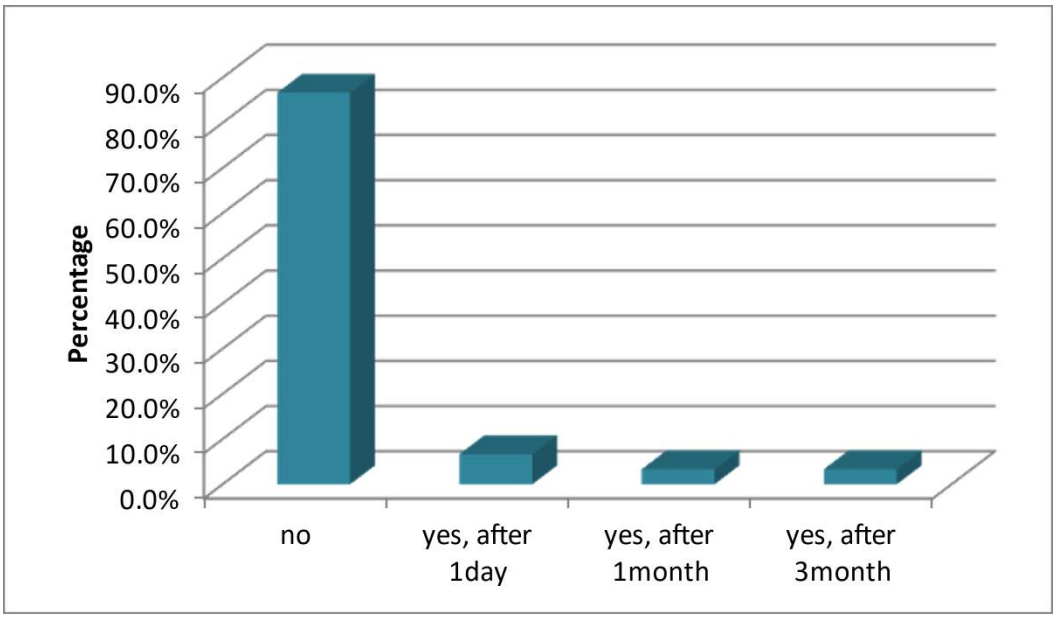

Figure 13: Distribution of patients according to recurrent hemoptysis

b) Complications other than recurrent hemoptysis

Chest pain was the most common immediate post BAE complication seen in n=4/30 ; 13.3% cases and self limited, persisted for few days followed by contrast induced nephropathy seen in n=1/30 patient

Table 13: Distribution of patients according to complications other than recurrent hemoptysis

Complication	No. of cases	Percentage
Chest pain	4	13.3%
Contrast nephropathy	1	3.3%
Intervention site hematoma	0	0.0%
Dysphagia	0	0.0%
Neurological	0	0.0%
Sepsis	0	0.0%
Pulmonary	0	0.0%
Vascular	0	0.0%

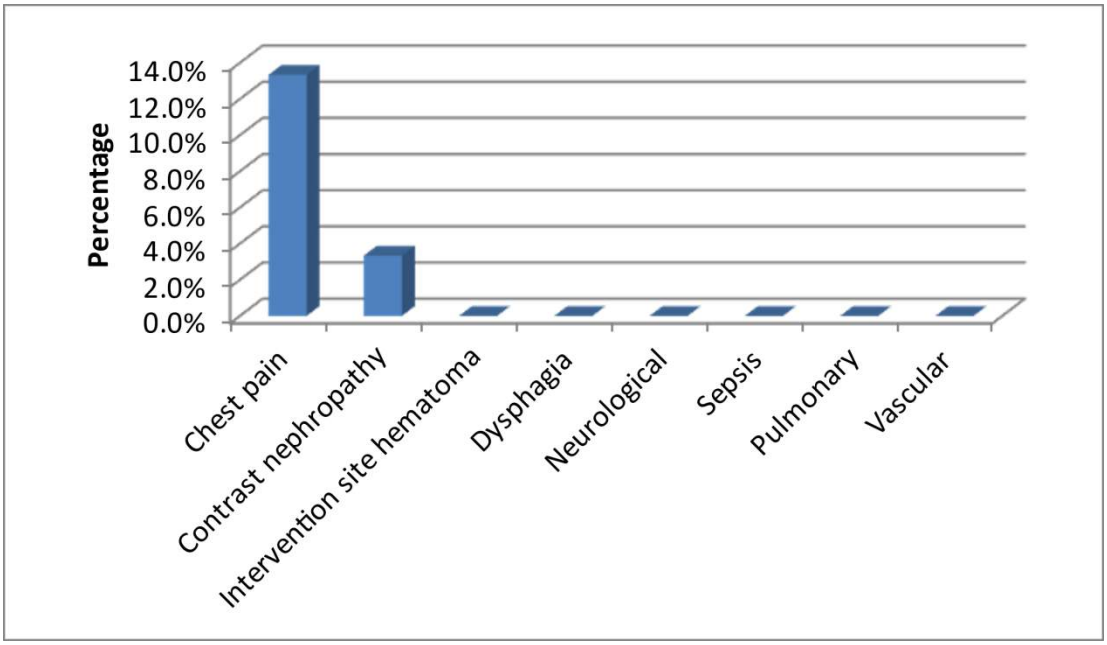

Figure 14: Distribution of patients according to complications other than recurrent hemoptysis

DISCUSSION

Hemoptysis is a life threatening respiratory emergency, whether the etiology is benign or malignant, the mechanism of hemoptysis remains the same that is hypertrophy or tortuosity of bronchial arteries to supply the blood to the diseased or ischemic tissue of lung.[11,20] Bronchial artery embolization, first performed by Remy etal in 1973, has become a widely accepted, minimally invasive treatment option in the management of patients presented with hemoptysis.[22] It is especially indicated in patients with massive hemoptysis where surgical interventions are contraindicated [23], in chronic recurrent hemoptysis and as a bridge to control immediate hemoptysis until definite surgical intervention measures are taken.

The purpose of this study was to evaluate the radiological findings and outcomes in patients who presented with hemoptysis and undergone Bronchial Artery Embolization (BAE)

A total of 45 patients were presented with hemoptysis to Dayanand Medical College and Hospital, Ludhiana during the time period between from 15th Nov. 2019- 15th May 2021. Of which 30 patients underwent BAE due to massive or chronic recurrent mild hemoptysis, were included in the study. Out of 45, 9 patients who presented with mild hemoptysis & were managed conservatively, 3 patients left the institution against medical advise and 3 patients less than 18 years of age were excluded from the study.

Our prospective study was conducted on n=30 patients who were presented with hemoptysis & referred to interventional radiologist for BAE. Out of 30 patients n=25; 83.3% were presented with massive hemoptysis and n=5; 16.7% with mild recurrent hemoptysis 80% of the patients in our study were males (n=24) with M:F ratio of 4:1. The age range of patients was between 18 to 89 years with mean age of 48.5 years & maximum number of patients in the study were between the age of 41 to 60 years (n=16, 53.3%). Pulmonary tuberculosis (n=18; 60%) whether active (n=9; 30%) or sequelae of old pulmonary tuberculosis (n=9; 30%) was the most common cause of hemoptysis.

This was followed by other active pulmonary infections other than tuberculosis (n=3; 10%), post COVID fibrosis (n=3; 10%), bronchial asthma with ABPA (n=2; 6.7%), branchial artery pseudoaneurysm formation (n=2; 6.7%), squamous cell carcinoma of lung (n=1; 3.3%) and in one of the patient cause of hemoptysis remain unknown.

Prasad at al [9] in their study observed that pulmonary tuberculosis was the most common cause of hemoptysis in 79.2% patient with majority of patients had moderate hemoptysis. Mishra at al [43] in his study showed that tuberculosis & its sequel as the most common etiology (65% patient) of hemoptysis. Poyanli A, Acunas B, Rozanes I, et al ,in their study on 140 patients (120 males and 20 females, aged 23–71 years, mean 44.1 years) with moderate to severe haemoptysis, who were poor candidates for surgical intervention because of limited pulmonary reserve were treated by bronchial artery embolisation. It was found that Haemoptysis was caused by tuberculosis in 136 (97.1%) patients and lung cancer in four (2.9%).[45] Thus, our study consistent with other studies, in particularly, done in developing countries like India with tuberculosis both active & its sequelae as the commonest cause of hemoptysis.

On pre-embolization radiological investigations like on chest X-rays multiple nodular opacities were found in most of patients (n=15; 50%) followed by consolidation (n=14; 46.7%), bronchiectasis (n=12; 40%), reticulonodular opacities (n=11; 36.7%) & fibrocystic / fibrocavitory changes (n=8;26.7%).However, on CT chest, consolidation is seen as the most common parenchymal finding (n=22; 73.3%), followed by bronchiectasis (n=15; 50%), cavitation (n=7; 23.3%), diffuse alveolar damage / ground glass haze (n=5; 16.7%), ABPA (n=2; 6.7%), fibrocystic changes (n=4; 13.3%). Military pattern was found in none of the patients neither on chest x-rays nor on chest CT. Revel et al.[46] in their study showed chest radiographs revealed abnormality in 87% of patients with hemoptysis while in 13% patients chest radiographs were normal. Diffuse bronchiectasis followed by consolidation, tracheal & bronchial tumors and non specific findings like ground glass opacities & alveolar opacifities were common findings found in both CT chest and

radiographs.Hirshberg et al [4] studied, 208 patients with hemoptysis and found that the most common causes of hemoptysis was bronchiectasis (20%) followed by lung cancer (19%), bronchitis (18%), and pneumonia (16%). Thus in comparison to above mentioned studies, current analysis shows the most common lung parenchymal findings were consolidation followed by bronchiectasis as maximum number of patients were of infective etiology both active tuberculosis and other bacterial infection.

In our study the left lung pathology was the most common cause of hemoptysis as compared to right lung with left upper lobe being affected most commonly. As compared to study done by knott craig & colleagues where they found right lung was the source in 62% & left lung in 38% with right upper lobe most commonly affected.[5] Most post primary tuberculosis cases show apical and upper lobe predominance which most likely related to increased oxygen tension and reduced lymphatic drainage in these regions, thus facilitating proliferation of Mycobacterial tuberculosis bacilli.[47,48] The maximum number of patients in our study were of pulmonary tuberculosis and thus lung parenchymal pathology was seen most commonly affecting upper lobes.

On pre-embolization CT angiogram, bronchial artery hypertrophy was found in n=25, 83.3% and bronchial artery tortuosity was found in n=23; 76.7% patients, however, arteriopulmonary shunting and active extravasation/leakage of intravenous contrast were found in none. In comparison to bronchial arteriogram under DSA, prior to BAE, arteriopulmonary shunting found in n=7/30 (23.3%) patients, pseudoaneurysm in n=2/30 (6.7% case) with frequency of bronchial artery hypertrophy & tortuosity remaining the same. Yoon W, Kim JK, Kim YH, et al in their study found that hypertrophied bronchial arteries, shunting into the pulmonary vasculature, hypervascularity / increased lung parenchymal staining , or aneurysm formation are more common angiographic finding as compared to active extravasation of iodinated contrast which is an exceedingly rare finding.[10] H. Dabó et al. in their study on 88 patients who underwent BAE, found that the main

angiographic abnormality was hypertrophy and tortuosity (n=68; 77.3%) of bronchial arteries, hypervasularity in n=40; 45.5% and contrast extravasation in n=2; 2.3%. Immediate success was achieved in 66 (98.5%) patients. Recurrence of hemoptysis occurred in 25 (37.3%) patients, and was related to presence of shunting (p=0.049). [49]. Thus our study was consistent with aforementioned studies, bronchial artery hypertrophy and tortuosity being most common findings on angiogram and DSA as well whereas arteriopulmonary shunting and increased parenchymal vascularity/staining were seen only on DSA, dynamically on cine images. Active extravasation of intravenous contrast being very rare finding was not seen in current analysis as well. Li et al. performed the first investigation with a control group to assess the clinical effect of BAE with preprocedural MDCT angiography for the management of hemoptysis.[44] Their study confirmed that a higher rate of immediate clinical success (97.2% vs. 88.2%) was achieved in group with MDCT angiography before BAE. As compared to the control group, it can also be useful to reduce the risk of recurrent hemoptysis (11.7% vs. 20.0%), especially early recurrence (3.9% vs. 13.3%).Thus MDCT angiography performed prior to BAE, helps us to identify the culprit vessels as well as provide a roadmap for management of hemoptysis.

In the current analysis, out of all the 39 orthoptic right bronchial arteries, 23 were seen originating from right ICBAT, 10 from CBT and 6 directly from proximal descending thoracic aorta as single right bronchial artery, while single left bronchial artery was seen in 15 patients out of 30 who underwent BAE. Thus as per Cauldwell classification[19] of variation of origin of bronchial artery anatomy, type II , pattern was the most common type of pattern observed in our study.

On pre-embolization, check angiogram, a total of 27 collaterals/aberrant arterieswere seen originating from intercostal arteries (n=9/27), both lateral thoracic arteries (right n = 2/27 ; left n=4/27), right thyrocervical trunk (n=2/27) , inferior arch of aorta (n=2/27), distal descending thoracic aorta (n=2/27) , both internal mammary arteries (right n=2/27 ; left n=3/27) and left dorsal scapular

artery (n=1/27). In present study, a total of 75 arteries were embolized with right ICBAT being the most common artery (n=19/75 ; 25.3%) followed by left orthoptic bronchial artery (n=14/75; 18.7%) , right orthoptic bronchial artery (n=12/75 ; 16%) , intercostal arteries (n=9/75; 12%), CBT (n=9/75; 12%), internal mammary artery (n=5/75; 6.7%), lateral thoracic artery (n=4/75 ; 5.3%), right thyrocervical trunk (n=2/75; 2.7%) and dorsal scapular artery(n=1/75 ; 1.3%). Chan et al. in their study did superselective catheterization and embolization of right bronchial artery in 65%, left bronchial artery in 52%, non bronchial collaterals from intercostal arteries in 33%, internal mammary artery in 12% and subclavian and its branches in 13% patients.[50] Shao et al. found culprit arteries in patients with hemoptysis seen originating from right bronchial artery in 29%, left bronchial artery in 21%, CBT in 18% , Right ICBAT in 2% and non bronchial collaterals from intercostal arteries in 42%& internal mammary artery in 17% patients.[51] In our study, the maximum number of collaterals/aberrant arteries which we embolized were from intercostal arteries followed by internal mammary, lateral thoracic arteries, right thyrocervical and dorsal scapular arteries. Thus search of non bronchial collaterals and their embolization reduce the overall rates of recurrence and thereby better control of hemoptysis.[41]

Out of 30 patients who underwent BAE, immediate control of hemoptysis was achieved in n=26; 86.7% patients and in n=4; 13.3% patients recurrent hemoptysis seen. In 2 patients, recurrent hemoptysis occur after 1 day, one of which underwent Video-assisted thoracoscopic surgery (VATS) lobectomy, and the other one died most likely secondary to post COVID complication. In rest of the 2 patients, recurrent hemoptysis occurred after 1 month and 3 month respectively, for which they underwent VATS lobectomy. Tamura et al. in their study described pleural thickening as a risk factor for recurrent bleeding after BAE. Also the presence of pleural thickening, non-bronchial systemic feeder vessels that originate from various non bronchial systemic arteries (e.g., intercostals artery, branches of the subclavian & axillary arteries, internal mammary artery and inferior phrenic artery) may

develop along the pleural surface and become enlarged as a result of the inflammatory process.[52] Osaki et al. found that bronchiectatic change on CT scan and pulmonary-bronchial shunt had some statistical significance as a major risk factor of recurrence after BAE[53].Kim et al.6 described the underlying lung disease and amount of bleeding as reliable risk factors for the recurrence, in a study involving 75 patients with a result estimating 54.5 % of re-bleeding rate after 3 years.[54] In our study, the major cause of recurrent hemoptysis in n=3/4 patients was fibrocystic/ fibrobronchiectatic changes secondary to pulmonary tuberculosis with chronic pulmonary tubercular sequalae in n=2/4 and active tubercular bronchopneumonia in n=1/4 patients. These were associated with marked pleural thickening with multiple tortuous, predominantly thin collaterals from systemic arteries, which couldn't be embolized even with superselective catheterization. Aside from this all the major vessel from where collaterals are arising cannot be embolization and formation of new collaterals is quite high from other vessels to supply the diseased/ischemic portion of the lung. Also the cause and frequency of recurrent hemoptysis depend on the basic underlying lung pathology.

In our study, apart from recurrent hemoptysis, chest pain was the most common immediate post BAE complication seen in n=4/30 ; 13.3% cases and self limited, persisted for few days followed by contrast induced nephropathy seen in n=1/30 patient. Anuradha et al evaluated the results of BAE in 58 patients with post-TB sequelae with the following post-procedure complications: chest pain in 20 (34.5%), dysphagia in 3 (5%), transient dissection of bronchial and intercostal arteries in 2 (3.4%) patients.[41] Also various other studies reported chest pain is the most common complication with prevalence seen varying from 24-91%.[36,55,56] Thus chest pain remained the most common complication following BAE in present study as well as in aforementioned study. Rest of the major complications like intervention site hematoma, dysphagia, spinal cord ischemia, paraparesis, transverse myelitis or other vascular complications were not seen in our study.

Limitations of study:

- First, this study was a single centre study with relatively small sample size (n=30), with COVID pandemic being one of the major cause
- Effectiveness of BAE in patients with hemoptysis secondary to post COVID fibrosis as very limited data is available in literature currently.
- Relatively short time period of follow up (upto 3 months) of patients who underwent BAE.

SUMMARY AND CONCLUSION

Hemoptysis, especially massive(>200ml), is a life threatening respiratory emergency which occurs due to various etiologies including tuberculosis, bronchiectasis, fungal infection, cystic fibrosis , arteriovenous malformations , lung carcinomas etc.

Tuberculosis, either active or from sequalae of prior infection being the most common cause of hemoptysis especially in developing countries like India.

BAE is life saving and minimally invasive interventional radiological technique and has become a widely accepted, first line treatment option in the management of patients with haemoptysis.

MDCT angiography should be performed prior to BAE, which helps us to make diagnosis, identify the culprit vessels as well as provide a roadmap for management of hemoptysis. Thus it also overall reduces time and risk of radiation exposure as well , especially to the intervention radiologist.

With the current use of particulate embolic agents greater than 350 mm and modern microcatheters or microguidewires, nontarget embolization is quite rare, thus the risk of major complications like spinal cord ischemia and other vascular complications should be rare.

Chest pain, apart from recurrent hemoptysis, is commonly occurred complication with selective embolisation within the first week following the procedure secondary to interruption of blood supply to the posterior mediastinum and mid esophagus.

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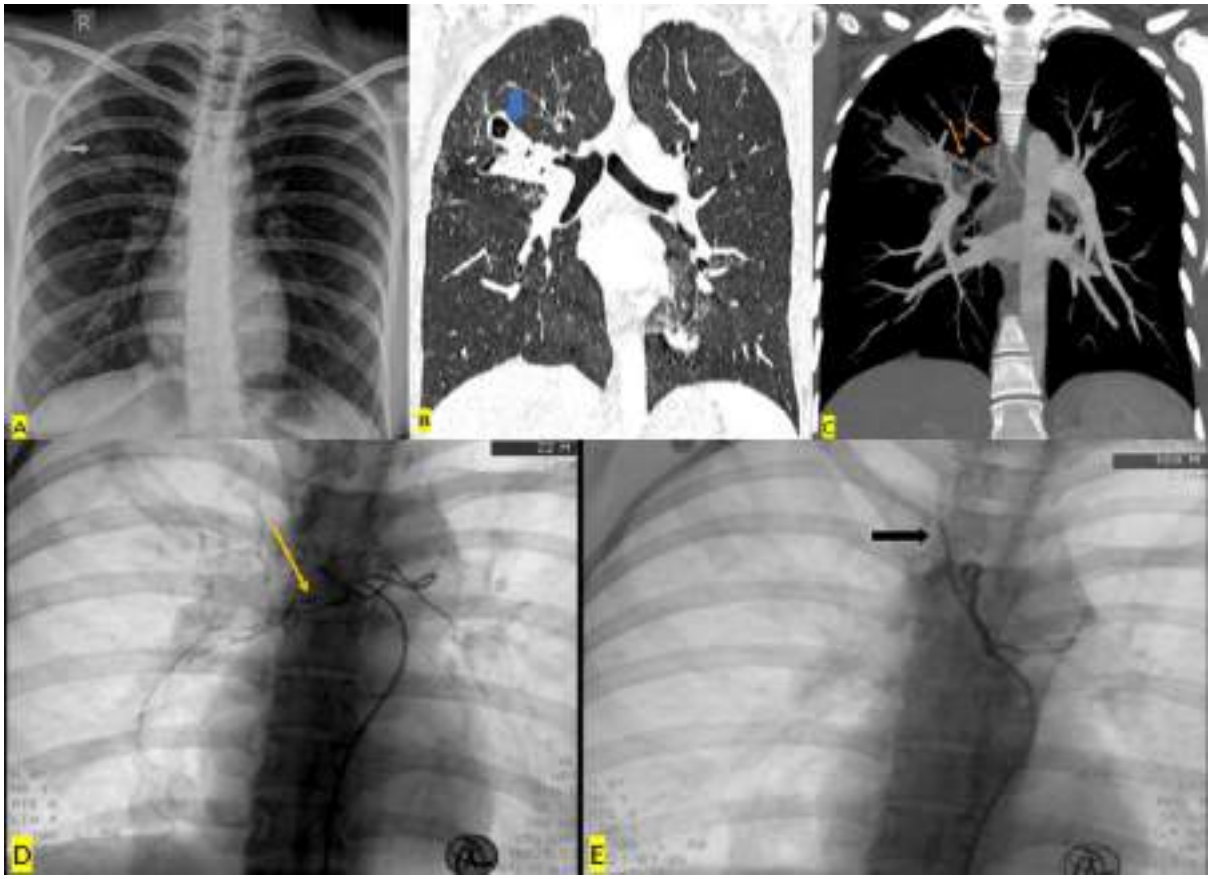
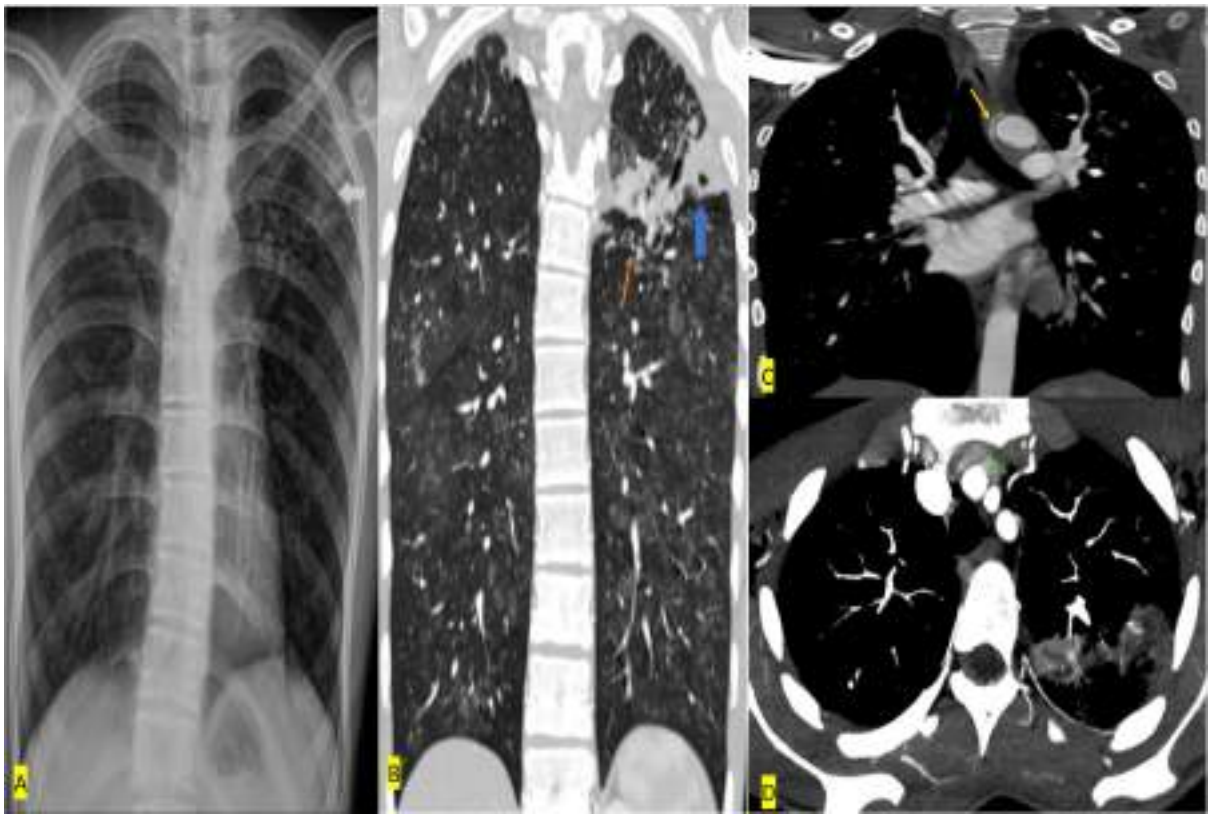


Case 1: 25 years female, known case of bronchial asthma with ABPA , presented with massive hemoptysis, chest radiograph PA view, in image A, shows tubular opacity in right mid zone(white arrow).Coronal CT chest, image B, shows central varicoid bronchiectasis (blue arrow) with impacted mucous and surrounding ground glass haze in right upper lobe. Corresponding image C, of CT angiogram shows dilated and tortuous right bronchial artery arising from ICBAT (orangearrow) which is seen traversing along dilated mucous filled right upper lobe bronchus. Image D, of bronchial arteriogram under DSA, shows hypertrophied and tortuous right bronchial artery (yellow arrow) which on post BAE (Image E) shows near stasis of contrast (black arrow)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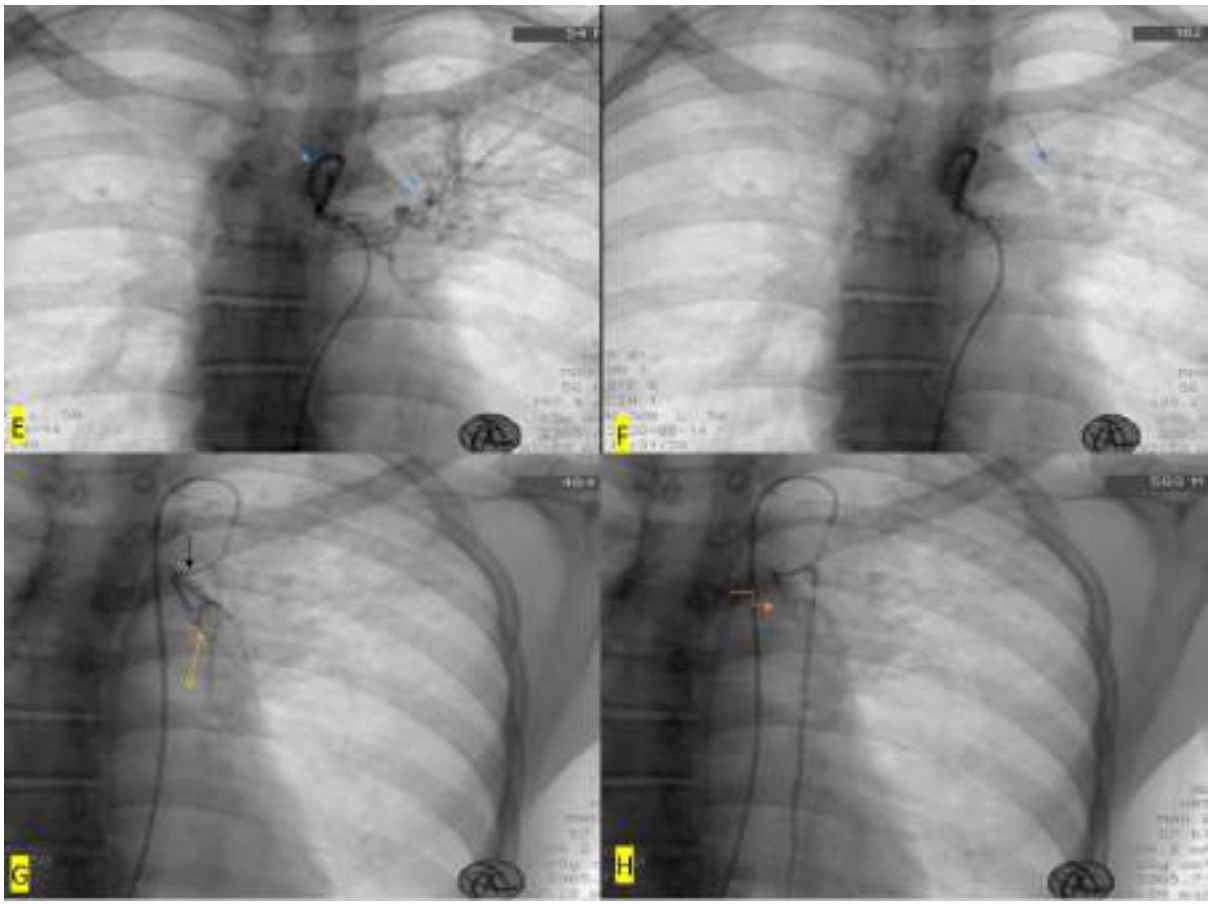
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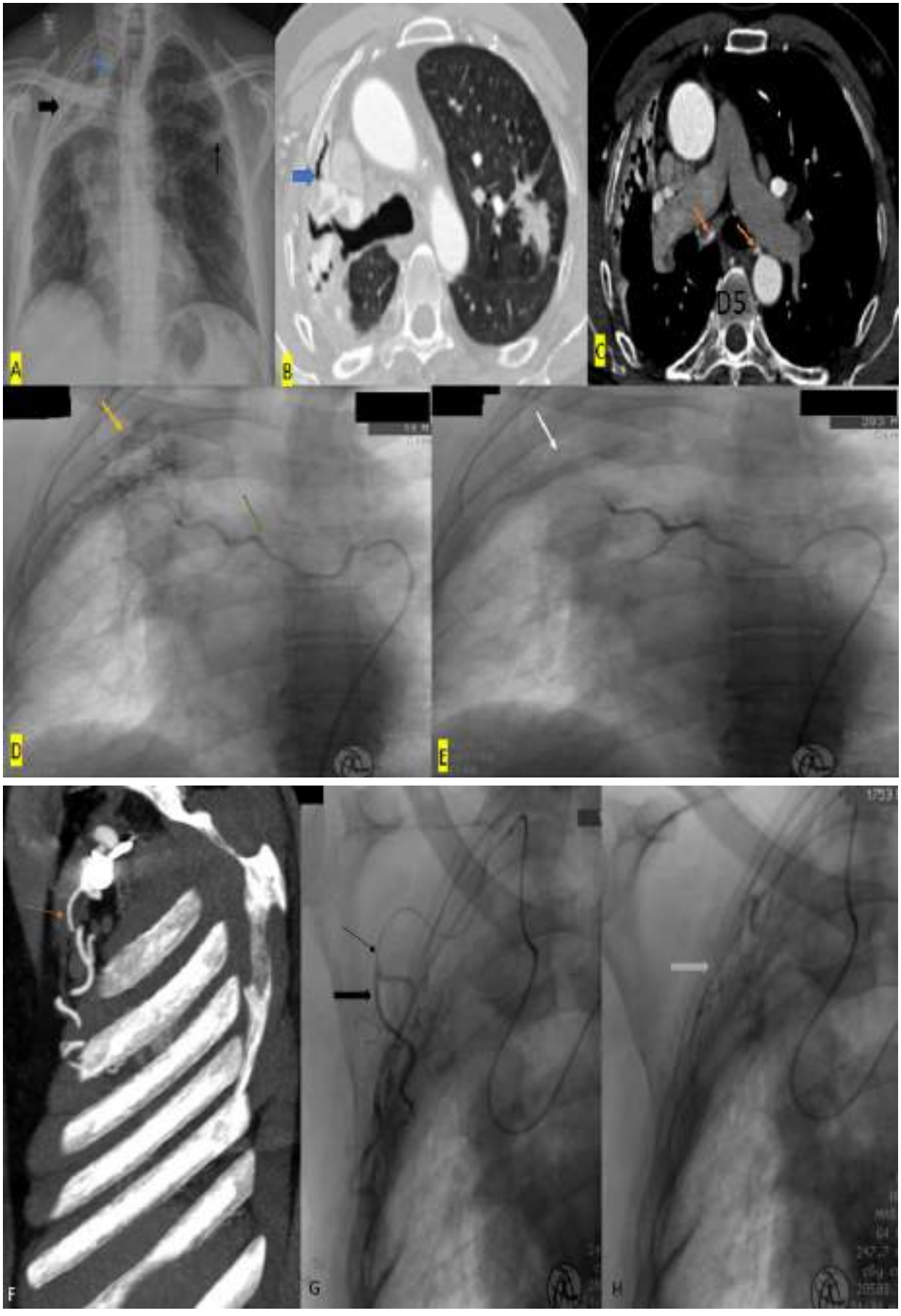
Case 2: 18 year old male, known case of active pulmonary tuberculosis on ATT for 2 months, presented with massive hemoptysis. Chest radiograph PA view, in image A, shows inhomogenous opacity with surrounding nodules(white arrow) in left upper zone. Coronal CT chest(image B) shows patch of consolidation with cavitation and focal bronchiectasis in left upper lobe (blue arrow) & multiple centrilobular nodules giving tree in bud appearance in rest of the lung parenchyma(orange arrow). On axial CT angiogram ,imageC, hypertrophied left bronchial artery is seen arising from aorta at level of D6 vertebral body (yellow arrow) and an aberrant left bronchial artery is seen arising from left mammary artery(green arrow) in image D. Pre-embolization DSA, image E, shows hypertrophied left bronchial artery (blue arrow) with increase parenchymal staining in left upper lobe. Post BAE, corresponding DSA, image F, shows near stasis of contrast (blue arrow). Image G, shows superselective cannulation of aberrant left bronchial artery which is hypertrophied and tortuous(double headed yellow arrow) arising from left internal mammary artery using microcatheter (thin black arrow). Post embolization corresponding check angiogram, image H , shows complete stasis of contrast (orange elbow arrow).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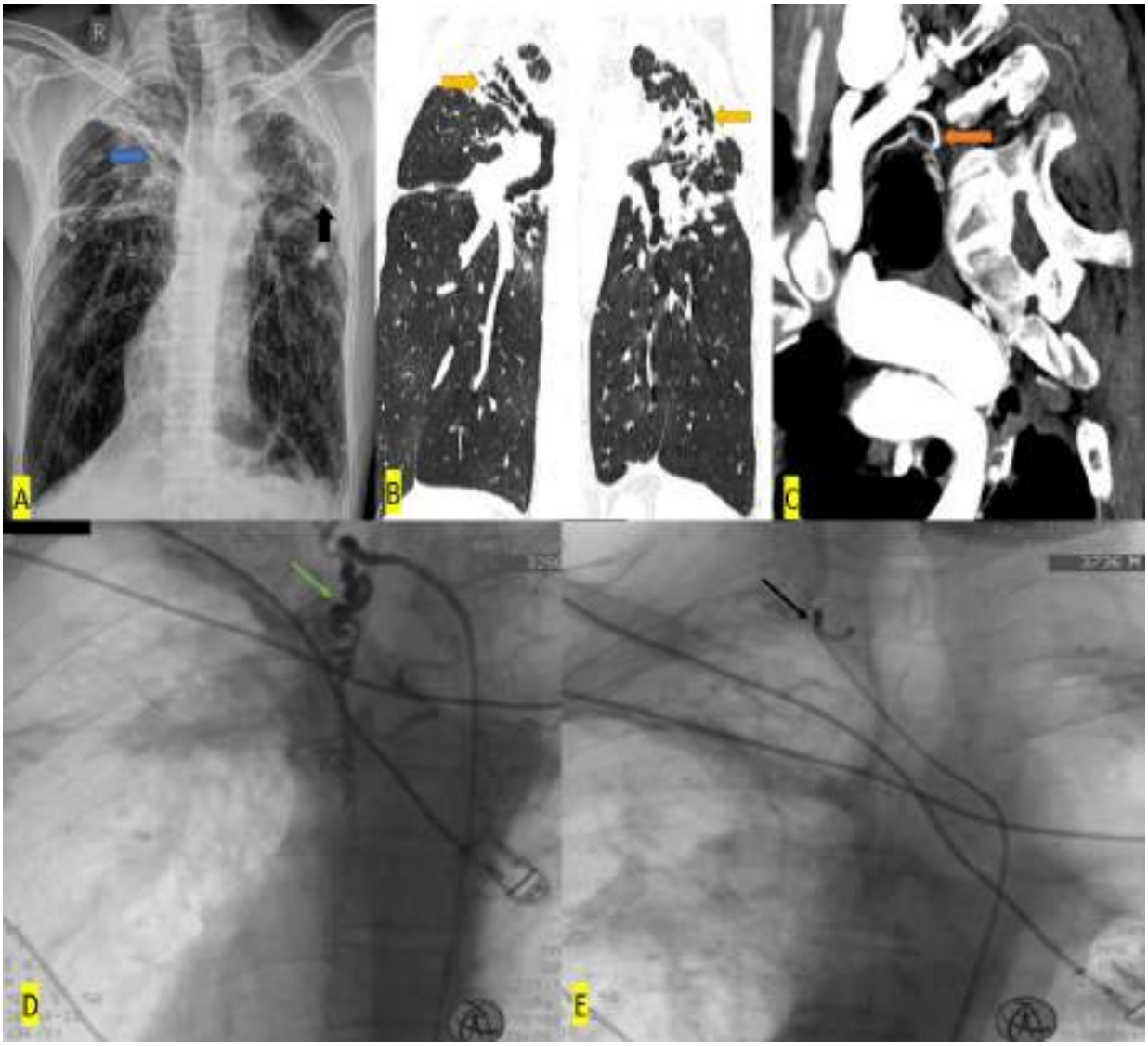
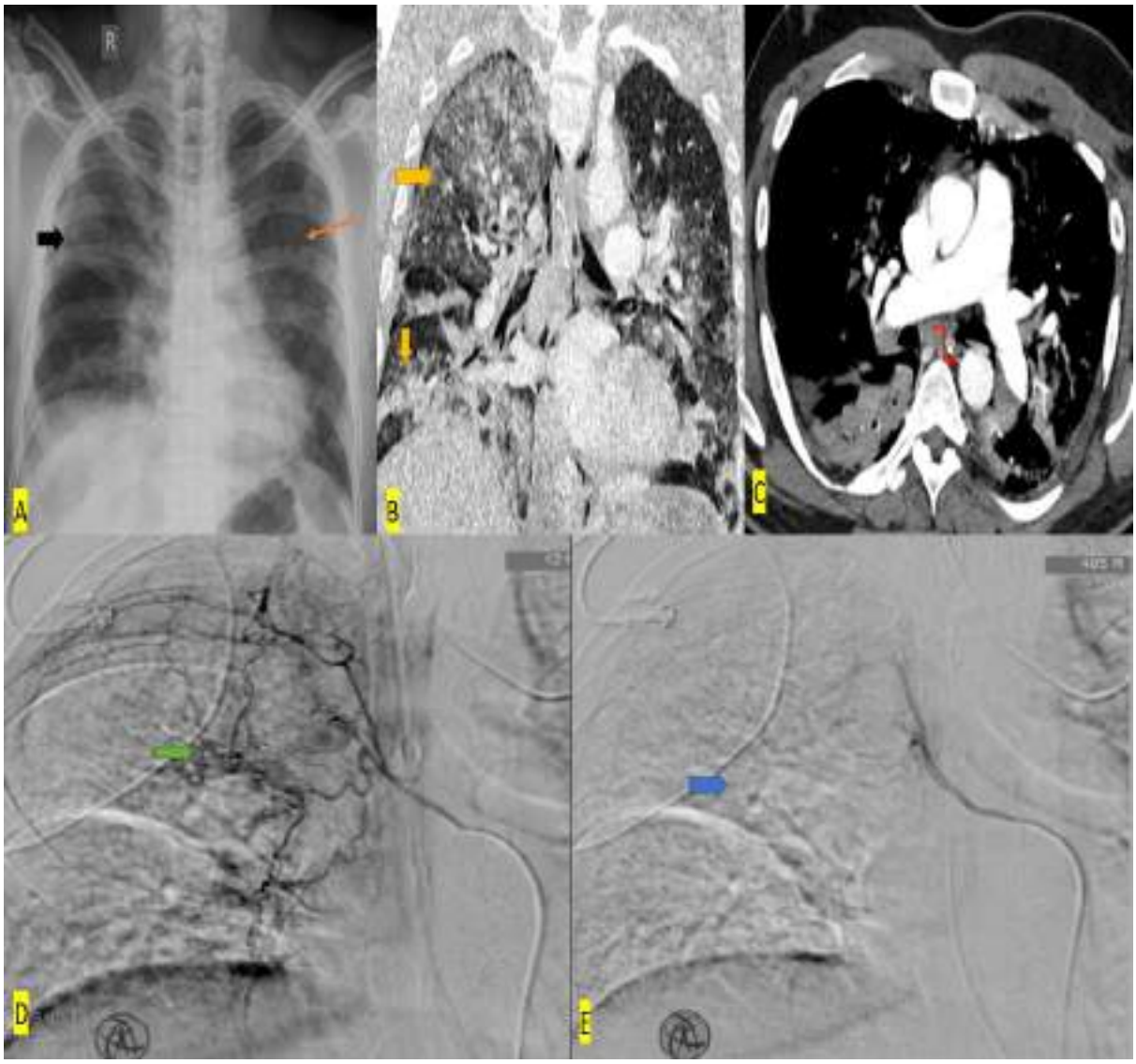
Case 3: 66 year old male, old treated case of pulmonary tuberculosis presented with massive hemoptysis. Chest X ray PA view, image A, shows homogenous opacity right upper zone(black arrow) with associated pleural thickening and ipsilateral tracheal & mediastinal shift(blue arrow). Axial CT image B, shows destroyed right upper lobe with fibrobronchiectatic changes (blue arrow) with ipsilateral mediastinal shift. A large fibronodular opacity is also seen in left upper lobe in the background of mosaic attenuation. Axial CT angiogram, image C shows hypertrophied right bronchial artery originating from slightly anteromedial aspect of proximal descending thoracic aorta (orange arrow) at the level of D5 vertebral body and is traversing along right main stem bronchus. Pre- embolization arteriogram , in image D, shows hypertrophied right bronchial artery (green arrow) with increase in parenchymal staining in right upper lobe (yellow arrow). Post BAE corresponding, imageE, shows no focal parenchymal staining/ blush (white arrow). Sagittal reformatted image F, in the same patient shows hypertrophied and tortuous right lateral thoracic artery (thin orange arrow). Image G, shows superselective cannulation of right lateral thoracic artery using microcatheter (thin black arrow) and tortuous & dilated right lateral thoracic artery (bold black arrow). Post embolization corresponding check angiogram, image H, shows near complete stasis of contrast (white bold arrow).

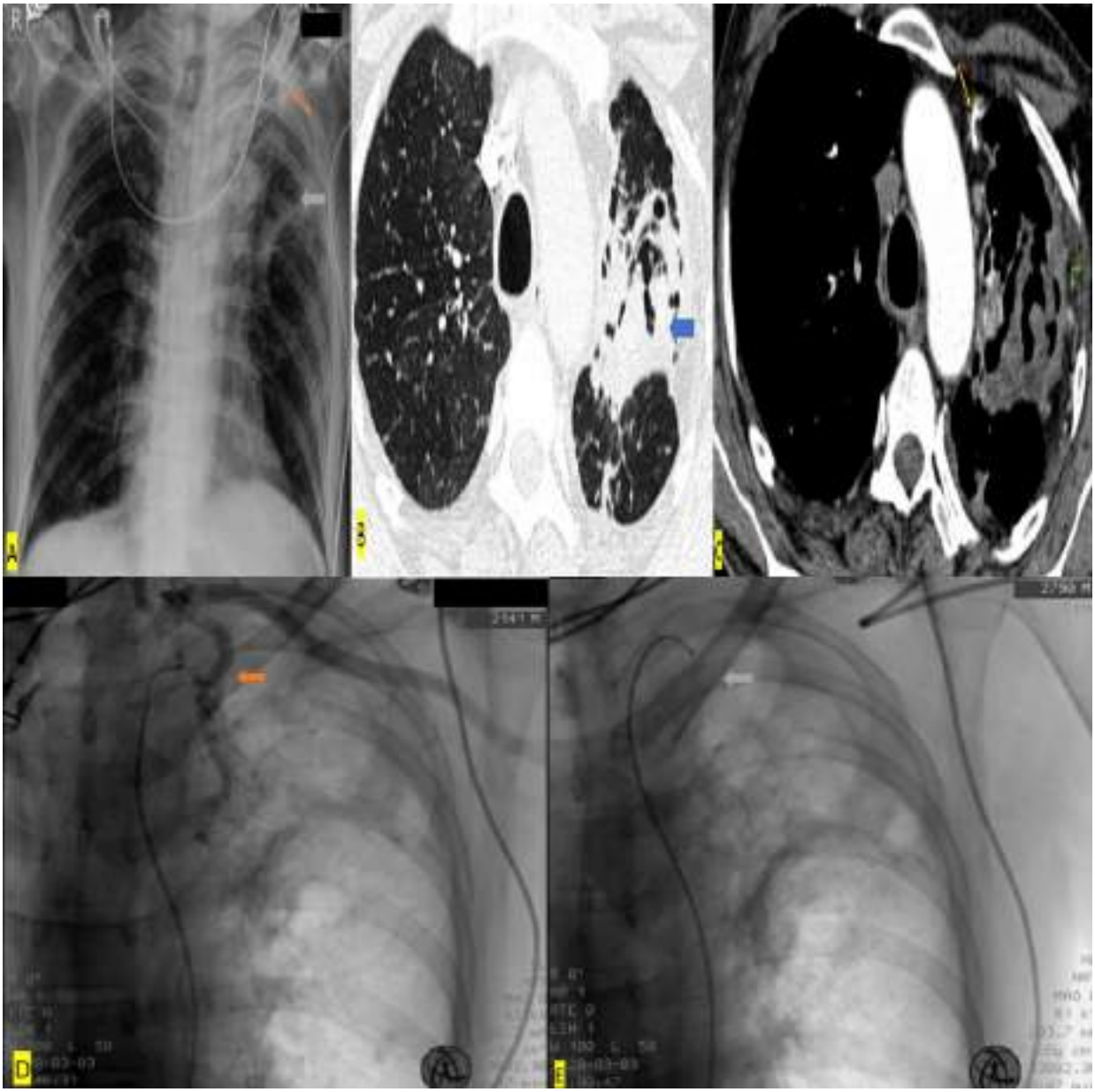


Case 4: 55 year male, old treated case of pulmonary tuberculosis , presented with massive hemoptysis. Image A, of chest Xray PA view, shows fibrobronchiectatic changes(arrows) in both upper lobes with distortion of hila. Coronal CT chest image B, shows fibrobronchiectatic changes in both upper lobes (bold yellow arrows) with distortion and upward pulling of hila. Sagittal reformatted CT angiogram, image C, shows hypertrophied and tortuous collateral (bold orange arrow) from thyrocervical trunk, which is also seen on pre-embolization angiogram (green arrow) in image D. Post embolization check angiogram, image E, shows complete embolization of the collateral (black arrow).

Case 5:53 years, male, chronic smoker, presented with recurrent mild hemoptysis .Chest radiograph PA view(image A) is grossly normal. Axial CT chest image B, shows multiple centrilobular nodules of ground glass(arrow) haze are seen in both upper lobes, however in image C, in mediastinal window, no abnormal bronchial artery hypertrophy/tortuosity seen. In image D, on check Bronchial artery angiogram, an aneurysmal outpouching (blue arrow) is seen from one of the branch of right bronchial artery. On post embolization DSA, image E, no abnormal pseudoaneurysm seen at the corresponding site.



Case 6: 35 years male, status Post COVID, presented with massive hemoptysis. Chest radiograph PA view, in image A, shows inhomogenous opacities with reticulations in right upper, mid zones(black arrow)and left lung(orange arrow). On coronal CT chest, image B, shows patches of consolidations with reticulations and ground glass haze (bold yellow arrows) in both lungs (right>left) in peribronchovascular and subpleural locations & loss of volume of bilateral lower lobes. Axial CT angiogram, image C, shows right ICBAT (red elbow arrow) which is normal in calibre and patches of consolidation in bothlungs. Pre-embolization check angiogram , image D, shows right bronchial artery arising from ICBAT which appears normal in calibre, however there is increase parenchymal staining in right lung (greeen arrow) which on post BAE check angiogram , image E, shows near complete resolution of the same (bold blue arrow).



Case 7: 51 year male, old treated case of pulmonary tuberculosis, presented with massive hemoptysis. Image A, chest radiograph PA view, shows fibrocystic changes(white arrow) in left upper zone with associated pleural thickening(orange arrow). Axial CT image B, shows fibrocystic/fibrobronchiectatic changes in left upper lobe(blue arrow). Axial CT angiogram, image C, shows dilated and tortuous left internal mammary artery(yellow arrow). Pleural thichening is also seen in left upper lobe(green shoulder arrow)through which multiple collaterals are seen traversing. In image D, on check aortic angiogram, dilated tortuous left internal mammary artery (orange arrow)is seen.On post embolization DSA, image E, no abnormallydilated artery is seen at the corresponding site(white arrow).

Serial no.	Name	Age/ Gender	MRD no.	Hemoptysis	Chest X ray finding						
					Consolidation	Reticulondular	Bronchiectasis	Milliary pattern	fibrocystic/ fibrocavitory	Ground Glass haze	Nodule/ mass
1	R. S	58y/F	722197	mild recurrent	Lt mid zone	no	no	no	no	no	Lt mid zone
2	G. S	67y/M	707890	massive	Rt upper & mid zones	no	no	no	no	no	no
3	A. K. G	89y/F	82471	massive	no	no	no	no	no	no	no
4	M.K. B	60y/M	799754	massive	no	no	no	no	no	no	Rt mid zone
5	V. S	41y/M	905128	mild recurrent	no	no	no	no	no	no	no
6	B. S	29y/F	866262	mild recurrent	no	no	no	no	Lt upper zone	no	no
7	S. S	51y/M	908787	massive	no	Lt upper & mid zones	Lt upper & mid zones	no	Lt upper zone	no	Rt upper zone
8	G. S	18y/M	926378	massive	no	Lt upper zone	no	no	no	no	Rt upper zone
9	S. P	32y/M	927116	massive	no	Lt upper/mid & b/l lower zones	no	no	Rt mid zone	no	Lt upper,mid & b/l lower zones
10	P. N	20y/M	551983	massive	Lt mid zone	Lt mid zone	Lt mid zone	no	no	no	Lt mid zone
11	R. K	25 y/F	1008934	massive	no	no	Rt upper & mid zones	no	no	no	Rt parahilar location
12	G. S	35y/M	1129550	massive	Rt upper & mid zones	B/L upper & mid zones	no	no	no	no	no
13	H. S	43y/M	1105916	massive	B/l lungs	B/l lungs	no	no	no	no	B/L lungs
14	G. S	60y/M	1113692	massive	no	no	no	no	no	B/l lungs	no
15	T. D	56y/M	1087886	massive	Rt upper & b/l mid zones	no	no	no	no	no	no
16	G. S	73y/M	1190814	mild recurrent	Rt upper zone	no	no	no	no	no	no
17	A. K	61y/M	1188747	massive	Lt upper zone	no	Lt mid & lower zones	no	Lt upper zone	no	no
18	S. P. K	59y/F	1163059	massive	Rt mid zone	no	no	no	no	no	no
19	M. L	66y/M	909226	massive	Rt upper & mid zones	Lt upper zone	Rt upper & mid zone	no	Rt upper zone	no	Lt upper zone
20	M. J	27y/M	1051007	massive	Lt lower zone	no	no	no	no	no	Lt lower zone
21	S. K	54y/M	997649	massive	no	B/L upper & mid zones	Lt upper & mid zones	no	no	no	B/L upper & mid zones
22	M. I. T	53y/M	1010990	mild recurrent	no	no	no	no	no	no	no
23	S. S	51y/M	932271	massive	no	no	Rt upper zone	no	no	no	B/L upper zones
24	S. P	55y/M	936409	massive	no	B/L upper & mid zones	Rt upper zone	no	no	no	no
25	R. S	59y/M	997180	massive	Lt lung , Rt mid zone	no	no	no	Lt lung	no	no
26	S. R	55y/F	8885	massive	no	all lobes	all lobes	no	no	no	Lt lower zone
27	O. P	51y/M	704221	massive	no	no	Rt upper zone	no	Rt upper zone	no	Rt lower zone
28	S. K	20y/M	766944	massive	Rt lower zone	no	no	no	no	no	no
29	D. S	60y/M	705119	massive	Lt lower zone	no	Lt lower zone	no	Lt lower zone	no	no
30	S . S	27y/M	663790	massive	no	Rt upper & Lt mid zones	Lt mid & lower zones	no	no	no	Rt upper , mid & Lt lower zones

Serial no.	Name	CT findings						
		Parenchymal						
		Consolidation/ mass/ gg0	cavity	Bronchiectasis	Millary pattern	Fibrocystic/ Fibronodular/ Aspergillosis	DAD	Mediastinal lymph node
1	R. S	Lt upper lobe	no	no	no	no	no	present
2	G. S	Rt upper lobe	no	no	no	no	no	present
3	A. K. G	no	no	no	no	no	no	present
4	M.K. B	Rt post seg soft tissue mass	no	no	no	no	no	present
5	V. S	apicoposterior seg of Lt upper lobe	no	no	no	no	no	no
6	B. S	no	no	left upper lobe	no	fibrocystic/ Fibrocavitory changes Lt upper lobe	no	present
7	S. S	no	Left upper lobe	rt middle lobe & anterior seg of left upper lobe	no	fibrocystic/ Fibrocavitory changes Lt upper lobe	no	present
8	G. S	apicoposterior segment of Lt upper lobe with GGO in B/l lungs	no	apicoposterior seg Lt upper lobe	no	no	no	present
9	S. P	B/L lower lobes, Rt middle & Lt upper lobes	B/L lower lobes, Rt middle & Lt upper lobes	B/L lower lobes, Rt middle & Lt upper lobes	no	no	no	present
10	P. N	Superior seg Lt lower lobe	no	Superior seg Lt lower lobe	no	no	no	present
11	R. K	no	no	Rt upper & posterobasal seg of Rt lower lobes	no	no	no	present
12	G. S	GGO with reticulations B/L lungs	no	no	no	no	no	present
13	H. S	Reticulations with GGO B/L lungs	no	no	no	no	B/L Lungs	present
14	G. S	GGO with reticulations B/L lungs	no	no	no	no	B/l Lungs	present
15	T. D	apical seg Rt upper, superior seg Rt lower & apicoposterior seg of Lt upper lobe	apical seg Rt upper lobe	no	no	no	no	present
16	G. S	Consolidation with ggo & few centrilobular nodules Rt upper lobe	no	no	no	no	Rt upper lobe	present
17	A. K	Lt upper lobe	Left upper lobe	left upper lobe	no	Fungal ball left upper lobe	no	no
18	S. P. K	peribronchial cosolidation with centrilobular nodules Rt lung	no	no	no	no	no	present
19	M. L	Lt upper lobe	no	Rt upper lobe	no	no	no	present
20	M. J	Lingular seg of Lt upper & posterobasal seg of Lt lower lobes	no	no	no	no	no	no
21	S. K	GGO rt middle, Lt upper & B/L lower lobes	Lt apical seg	Lingular seg of Lt upper lobe	no	no	no	present
22	M. I. T	GGO left upper lobe	no	no	no	no	Lt upper lobe	no
23	S. S	no	no	no	no	no	no	present
24	S. P	no	no	b/l upper lobes , superior seg og b/l lower lobes	no	no	no	no
25	R. S	Lt upper lobe, apical seg of Rt upper & superior seg of Rt lower lobe	Lt upper lobe, apical seg of Rt upper & superior seg of rt lower lobe	no	no	no	no	present
26	S. R	no	no	All lobes	no	no	no	present
27	O. P	Rt middle , B/L lower lobes	no	Rt upper lobe	no	fibrocystic changes B/l upper lobe	no	present
28	S. K	medial seg of Rt middle lobe	no	no	no	no	Rt middle lobe	present
29	D. S	Lt lower lobe	Left lower lobe	Lt lower lobe & lingular seg of left upper lobe	no	no	no	present
30	S . S	no	no	B/L upper & Lt lower lobes	no	fibrocystic changes B/l upper lobe	no	present

Serial no.	Name	Vascular				Orthoptic	
		Hypertrophy of artery	Tortuous Artery	Active extravasation	Aneurysm		inferior arotic arch
1	R. S	Rt bronchial artey	no	no	no	no	no
2	G. S	Rt bronchial artey	no	no	no	no	no
3	A. K. G	Rt bronchial artey	no	no	no	Left from descending thoracic aorta at D6 level anterolaterally	no
4	M.K. B	both rt & Lt bronchial arteries	no	no	no	Left from descending thoracic aorta at D6 level anterolaterally	no
5	V. S	both rt & Lt bronchial arteries	no	no	no	no	no
6	B. S	both rt & Lt bronchial arteries	both rt & Lt bronchial arteries	no	no	Left from descending thoracic aorta at D6 level anterolaterally	no
7	S. S	both rt & Lt bronchial arteries	both rt & Lt bronchial arteries	no	no	Left from descending thoracic aorta at D5 level anteriorly	no
8	G. S	both rt & Lt bronchial arteries	both rt & Lt bronchial arteries	no	no	1 Rt & 1Lt from descending thoracic aorta at D6 level medially	no
9	S. P	both rt & Lt bronchial arteries	both rt & Lt bronchial arteries	no	no	no	no
10	P. N	Lt bronchial artery	Lt bronchial artery	no	no	Left from descending thoracic aorta at D6 level anteriorly	no
11	R. K	2 Rt bronchial arteries From ICBT & CBT	2 Rt bronchial arteries From ICBT & CBT	no	no	no	no
12	G. S	no	both rt & Lt bronchial arteries	no	no	no	no
13	H. S	both rt & Lt bronchial arteries	both rt & Lt bronchial arteries	no	no	Rt &Lt from prox descending thoracic aorta at lower & upper border of D5 resp	no
14	G. S	1 Rt from ICBT, 1 Rt from CBT & 1 Lt from CBT	1 Rt from ICBT, 1 Rt from CBT & 1 Lt from CBT	no	no	no	no
15	T. D	Rt bronchial, collateral from Rt thyrocervical trunk & Rt posterior 1st intercostal artery	no	no	no	Left from descending thoracic aorta at D6 level anterolaterally	no
16	G. S	Two Rt & 1 left broncial arteries	Two Rt & 1 left broncial arteries	no	no	Rt &Lt from prox descending thoracic aorta at lower & upper border of D5 resp	no
17	A. K	Lt bronchial artery	Lt bronchial artery	no	no	Left from descending thoracic aorta at D5 level anteriorly	no
18	S. P. K	no	no	no	no	Rt &Lt from prox descending thoracic aorta at lower & upper border of D5 resp	no
19	M. L	2 Rt bronchial arteries with multiple collaterals from Rt 1 to 4 intercostal arteries, Rt thyrocervical trunk & Rt axillary arteries	Both Rt bronchial arteries	no	no	Rt from prox descending thoracic aorta at D 5-6 level anteriorly	at D3 level
20	M. J	no	Lt bronchial artery from CBT	no	no	no	no
21	S. K	1 Rt & 2 Lt bronchial artery	1 Rt & 2 Lt bronchial artery	no	no	2 Lt from descending thoracic aorta at D5 & D6 levels anteriorly	no
22	M. I. T	no	no	no	no	no	no
23	S. S	Rt bronchial artery	Rt bronchial artery	no	no	no	no
24	S. P	both rt & Lt bronchial arteries , b/l lateral thoracic arteries	both rt & Lt bronchial arteries , b/l lateral thoracic arteries	no	no	Left from descending thoracic aorta at D6 level anterolaterally	no
25	R. S	2 Rt bronchial arteries From ICBT & CBT	2 Rt bronchial arteries From ICBT & CBT	no	no	no	no
26	S. R	both rt & Lt bronchial arteries	Multiple collateral anterior surface of thoracic aorta	no	no	Rt from prox descending thoracic aorta at D 5-6 level anteriorly	no
27	O. P	no	Rt bronchial arteries	no	no	no	Rt bronchial A
28	S. K	1 Rt from ICBT, 1 Rt from CBT	1 Rt from ICBT, 1 Rt from CBT	no	Yes	no	no
29	D. S	Lt bronchial artery from CBT	Lt bronchial artery from CBT	NO	NO	no	no
30	S . S	both rt & Lt bronchial arteries	both rt & Lt bronchial arteries	no	no	Left from descending thoracic aorta at D6 level anteriorly	no

Serial no.	Name	Arota			Ectopic in origin			other extrabronchial
		distal descending thoracic arota	intercostobronchial artery	common bronchial trunk	internal mammary artery	intercostal artery	subclavian artery	lateral thoracic artery
1	R. S	no	Rt ICBT from medial aspect of prox descending aorta at D6	from prox descending thoracic aorta anteriory at leve of D6	no	no	no	no
2	G. S	no	Rt ICBT from medial aspect of prox. Descending thoracic aorta at D6 level	from prox descending thoracic aorta anteriory at leve of D6	Rt	Rt	no	Rt
3	A. K. G	no	Rt ICBT from medial aspect of prox. Descending thoracic aorta at D6 level	no	no	no	no	no
4	M.K. B	no	Rt ICBT from medial aspect of prox. Descending thoracic aorta at D5 level	no	no	no	no	no
5	V. S	no	Rt ICBT from prox descending aorta at D5-6 levels	no	no	no	no	no
6	B. S	no	Rt from ICBT anteromedial aspect of thoracic aorta at D6 level	no	no	no	no	no
7	S. S	no	no	no	rt and left bronchial arteries	no	Lt dorsal scapular artery	Lt
8	G. S	no	no	no	Lt aberrant Bronchial artery	no	no	Lt
9	S. P	no	Rt ICBT from medial aspect of prox. Descending thoracic aorta at D5 level	At lower border of D4	no	no	no	no
10	P. N	no	Rt from ICBT anteromedial aspect of thoracic aorta at D6 level	no	no	no	no	no
11	R. K	no	Rt from ICBT anteromedial aspect of thoracic aorta at D5 level	from prox descending thoracic aorta anteriory at leve of D6	no	no	no	no
12	G. S	no	Rt from ICBT anteromedial aspect of thoracic aorta at D5 level	from prox descending thoracic aorta anteriory at leve of D6	no	no	no	no
13	H. S	no	no	no	no	no	no	no
14	G. S	no	Rt ICBT from medial aspect of prox. Descending thoracic aorta at D5 level	from prox descending thoracic aorta anteriory at leve of D5	no	no	no	no
15	T. D	no	Rt- ICBT from anteromedial aspect of prox descending aorta upper border of D5	no	no	Rt 1st posterior intercostal arteries	no	no
16	G. S	no	Rt ICBT from anteromedial aspect of prox descending thoracic aorta at lower border of D5	no	no	no	no	no
17	A. K	no	Rt from ICBT anteromedial aspect of thoracic aorta at D5 level	no	Lt Bronchial artery collaterals	no	no	Lt
18	S. P. K	no	no	no	no	no	no	no
19	M. L	no	no	no	no	Rt 1st to 4th posterior intercostal arteries	no	no
20	M. J	no	no	from prox descending thoracic aorta anteriory at leve of D6	no	no	no	no
21	S. K	no	Rt ICBT from medial aspect of prox. Descending thoracic aorta at D5 level	no	no	no	no	no
22	M. I. T	no	no	from prox descending thoracic aorta anteriory at upper border of D6	no	no	no	no
23	S. S	no	Rt ICBT from medial aspect of prox. Descending thoracic aorta at D5 level	no	no	Rt 1st & 2nd posterior intercostal arteries	no	no
24	S. P	no	Rt- ICBT from anteromedial aspect of prox descending aorta upper border of D5	no	no	no	no	B/l
25	R. S	no	Rt from ICBT anteromedial aspect of thoracic aorta at D6 level	from prox descending thoracic aorta anteriory at leve of D6	no	no	no	no
26	S. R	multiple collaterals to left lower lobe	Rt ICBT from medial aspect of prox. Descending thoracic aorta at D5 level	no	no	no	no	no
27	O. P	Lt bronchial artery	Rt ICBT from medial aspect of prox. Descending thoracic aorta at D6 level	no	no	no	no	no
28	S. K	no	Rt ICBT from medial aspect of prox. Descending thoracic aorta at D6 level	from prox descending thoracic aorta anteriory at upper border of D6	no	no	no	no
29	D. S	no	1 Rt from ICBT medial aspect of prox. Descending thoracic aorta at D5 level ;	from prox descending thoracic aorta anteriory at upper border of D6	no	Lt posterior intercostal arteries D8 to D10	no	no
30	S . S	no	Rt from ICBT anteromedial aspect of thoracic aorta at D5 level	no	no	no	no	no

Serial no.	Name	Cath lab findings			Artery					Artery en	
		thyrocervical trunk	brachiocephalic trunk	coronary artery	Hypertrophied	Torturous	Active extravasation	Aneurysm	arterio pulmonary shunting	Bronchial artery (R/L)	intercostals arteries (R/L)
1	R. S	no	no	no	yes	no	no	no	no	rt icbt & cbt	no
2	G. S	no	no	no	Yes	no	no	no	no	Rt icbt	Rt
3	A. K. G	no	no	no	yes	no	no	no	present	Rt icbt	no
4	M.K. B	no	no	no	yes	no	no	no	no	Rt icbt	no
5	V. S	no	no	no	yes	no	no	no	no	both rt & left(rt & lt icbt)	no
6	B. S	no	no	no	yes	yes	no	no	no	both rt & left (rt icbt)	no
7	S. S	no	no	no	yes	yes	no	no	no	both rt & left	no
8	G. S	no	no	no	yes	yes	no	no	no	both rt & left	no
9	S. P	no	no	no	yes	yes	no	no	no	2 rt & 1 left (rt icbt) (cbt)	no
10	P. N	no	no	no	yes	yes	no	no	present	Lt	no
11	R. K	no	no	no	yes	yes	no	no	no	both Rt (rt icbt) (cbt)	no
12	G. S	no	no	no	no	yes	no	no	present	1 Rt (rt icbt) & CBT (cbt)	no
13	H. S	no	no	no	no	yes	no	no	no	both rt & left	no
14	G. S	no	no	no	yes	yes	no	no	no	both rt & left (rt icbt) (cbt)	no
15	T. D	Rt thyrocervical trunk	no	no	yes	yes	no	no	no	both rt & left (rt icbt)	Rt 1st posterior intercostal
16	G. S	no	no	no	yes	yes	no	no	no	2 rt & 1 left (rt icbt)	no
17	A. K	no	no	no	yes	yes	no	no	no	Left bronchial artery	no
18	S. P. K	no	no	no	yes	no	no	no	no	both rt & left	no
19	M. L	Rt thyrocervical trunk	no	no	yes	yes	no	no	present	both Rt bronchial arteries	Rt 1st to 4th posterior intercostal
20	M. J	no	no	no	no	yes	no	no	no	Lt (cbt)	no
21	S. K	no	no	no	yes	yes	no	no	no	1 Rt(rt icbt) & 2 Lt bronchial artery	no
22	M. I. T	no	no	no	no	yes	no	yes from Rt	no	CBT (cbt)	no
23	S. S	no	no	no	yes	yes	no	no	no	Rt (rt icbt)	Rt 1st & 2nd posterior intercostal arteries
24	S. P	no	no	no	yes	yes	no	no	present	both rt & left (rt icbt)	no
25	R. S	no	no	no	yes	yes	no	no	no	CBT & ICBT (rt icbt) (cbt)	no
26	S. R	no	no	no	yes	yes	no	no	present	both rt & left (rt icbt)	no
27	O. P	no	no	no	no	no	no	no	no	both Rt (rt icbt)	no
28	S. K	no	no	no	yes	yes	no	yes from Rt	no	both Rt (rt icbt) (cbt)	no
29	D. S	no	no	no	Yes	Yes	no	no	no	CBT	Lt posterior intercostal arteries
30	S . S	no	no	no	yes	yes	no	no	no	Rt ICBT & Lt (rt icbt)	no

Serial no.	Name	bolized		Done with		Microcatheter used	Follow up next day			
		internal mammary artery	other branch from subclavian	gel foam	pva		Chest Xray	Intubation status	Hemodynamic status- BP/PR	hemoptysis
1	R. S	no	no	no	yes	no	nodules left mid zone	no	Stable 124/86 ; 76	no
2	G. S	Rt	Rt lateral thoracic artery	no	yes	yes	consolidation right upper and mid zone	no	Stable 130/80 ; 84	no
3	A. K. G	no	no	no	yes	no	grossly normal	no	Stable 130/70 ; 96	no
4	M.K. B	no	no	no	yes	no	persistent nodular lesion Rt parahilar location	no	Stable 141/92 ; 78	no
5	V. S	no	no	no	yes	no	grossly normal	no	Stable 140/86 ; 92	no
6	B. S	no	no	no	yes	no	fibrocystic/ Fibrocavitory changes Lt upper lobe	no	Stable 122/78 ; 80	no
7	S. S	both rt & Lt	Left dorsal scapular artery	no	yes	yes	homogenous haziness left upper & mid zones	yes	on ionotropes 100/70 ; 102	yes, after 1 day
8	G. S	Lt	Left lateral thoracic artery	no	yes	yes	reticulonodular opacities Lt upper zone	no	Stable 110/78 ; 80	no
9	S. P	no	no	no	yes	no	reticulonodular opacities Lt upper & B/L lower zones	no	Stable 122/74 ; 80	no
10	P. N	no	no	no	yes	no	Consolidation with reticulonodular opacities Lt mid zone	no	Stable 122/78 ; 82	Yes after 1 month
11	R. K	no	no	no	yes	no	Bronchiectasisn Rt upper & mid zones with few nodules	no	Stable 100/76 ; 86	no
12	G. S	no	no	no	yes	no	Inhomogenous haziness Rt upper & mid zones with reticulations B/L lungs	no	Stable 100/76 ; 86	no
13	H. S	no	no	no	yes	no	inhomogenous opacities B/L lunga	yes	on ionotropes 100/70 ; 102	yes , after 1 day
14	G. S	no	no	no	yes	no	inhomogenous opacities B/L lunga	no	Stable 134/88 ; 90	no
15	T. D	no	branch from thyrocervical trunk	no	yes	yes	Patch of cosolidation Rt upper & Lt mid zones	no	Stable 134/86 ; 90	no
16	G. S	no	no	no	yes	no	Inhomogenous haziness Rt upper zone	no	Stable 100/76 ; 86	no
17	A. K	left	Left lateral thoracic artery	no	yes	yes	Persistent fibrobronchiectatic changes with opacity Lt upper zone	no	Stable 120/70 ; 84	no
18	S. P. K	no	no	no	yes	no	inhomogenous opacity Rt mid zone	no	Stable 134/88 ; 90	no
19	M. L	no	collaterals from thyrocervical trunk & Rt axillary A	no	yes	yes	inhomogenous opacity Rt upper & mid zone with pleural thickening	no	Stable 122/78 ; 80	no
20	M. J	no	no	no	yes	no	inhomogenous opacity Lt lower zone	no	Stable 100/76 ; 86	no
21	S. K	no	no	no	yes	no	reticulonodular opacities B/L upper & mid zones	no	Stable 150/88 ; 92	no
22	M. I. T	no	no	no	yes	no	normal	no	Stable 134/98 ;88	no
23	S. S	no	no	no	yes	no	fibrocalcified nodules b/l upper zones	no	Stable 134/86 ; 90	no
24	S. P	no	B/L lateral thoracic arteries	no	yes	yes	fibrocalcified nodules b/l upper & mid zones	no	Stable 134/86 ; 90	no
25	R. S	no	no	no	yes	no	fibronodular opacities in Lt upper & b/l mid zones with bronchiectasis in Lt upper zone	no	Stable 130/76 ; 86	no
26	S. R	no	no	no	yes	no	Irregular cioarse reticulations with bronchiectasis all zones	no	Stable 110/70 ; 82	no
27	O. P	no	no	no	yes	no	Fibrocystic changes Rt upper & dense apacities Rt lower zones	no	Stable 134/98 ;88	no
28	S. K	no	no	no	yes	no	Grossly normal	no	Stable 134/86 ; 90	no
29	D. S	no	no	no	yes	yes	Homogenous opacity left left lower lobe with bronchiectasis	no	Stable 138/70 ;82	Yes after 3 month
30	S . S	no	no	no	yes	no	Reticulonodular opacities Rt upper & Lt mid zones with bronchiectasis Lt mid & lower zones	no	Stable 122/78 ; 82	no

Serial no.	Name	Post procedure											Final diagnosis
		HB	Other outcome										
			hemostasis achieved	recurrence of hemoptysis	chest pain	dysphagia	intervention site hematoma	vascular	pulmonary	sepsis	contrast nephropathy	neurological	
1	R. S	10.4	yes	no	no	no	no	no	no	no	no	no	Granulomatous etiology likely tubercular
2	G. S	10.8	yes	no	no	no	no	no	no	no	no	no	Sequelae of Old pulmonary tuberculosis
3	A. K. G	12.2	yes	no	yes	no	no	no	no	no	no	no	Tubercular Lymphadenitis
4	M.K. B	13.6	yes	no	no	no	no	no	no	no	no	no	Squamous cell ca of lung
5	V. S	12.6	yes	no	no	no	no	no	no	no	no	no	LRTI ; sputum positive for Pseudomonas
6	B. S	8.3	yes	no	no	no	no	no	no	no	no	no	Sequelae of Old pulmonary tuberculosis
7	S. S	8.5	no	yes ; pt undervent VATS lobectomy	no	no	no	no	no	no	no	no	Post tubercular pulmonary cavity with chronic inflammatory changes
8	G. S	8.8	yes	no	yes	no	no	no	no	no	no	no	Pulmonary tuberculosis ; CBNAAT positive
9	S. P	9	yes	no	no	no	no	no	no	no	no	no	Pulmonary tuberculosis ; CBNAAT positive
10	P. N	12.1	no	yes ; pt undervent VATS lobectomy	no	no	no	no	no	no	no	no	Tubercular bronchopneumonia ;
11	R. K	9.8	yes	no	no	no	no	no	no	no	no	no	ABPA with active infectious bronchiolitis
12	G. S	11.8	yes	no	no	no	no	no	no	no	no	no	Post COVID fibrosis & hemoptysis
13	H. S	8.1	no	yes : died due to COVID related complications	no	no	no	no	no	no	no	no	Post COVID fibrosis & hemoptysis
14	G. S	9.5	yes	no	no	no	no	no	no	no	no	no	Post COVID fibrosis & hemoptysis
15	T. D	11.5	yes	no	no	no	no	no	no	no	no	no	Pulmonary tuberculosis ; CBNAAT positive
16	G. S	13.5	yes	no	no	no	no	no	no	no	no	no	non specific LRTI ; pt was put on emperical antibiotics
17	A. K	8.6	yes	no	no	no	no	no	no	no	Yes	no	Sequelae old pulmonary Koch's with fungal ball left upper lobe
18	S. P. K	11.9	yes	no	no	no	no	no	no	no	no	no	Pulmonary tuberculosis ; CBNAAT positive
19	M. L	10.7	yes	no	no	no	no	no	no	no	no	no	Sequelae of Old pulmonary tuberculosis
20	M. J	10.9	yes	no	no	no	no	no	no	no	no	no	Etiology remained unknown
21	S. K	11.5	yes	no	yes	no	no	no	no	no	no	no	Pulmonary tuberculosis ; CBNAAT positive
22	M. I. T	12.5	yes	no	yes	no	no	no	no	no	no	no	pseudoaneurysm of one of bronchial artery
23	S. S	13.1	yes	no	no	no	no	no	no	no	no	no	Sequelae of Old pulmonary tuberculosis
24	S. P	10.3	yes	no	no	no	no	no	no	no	no	no	Sequelae of Old pulmonary tuberculosis
25	R. S	11.9	yes	no	no	no	no	no	no	no	no	no	Pulmonary tuberculosis ; CBNAAT positive
26	S. R	9.6	yes	no	no	no	no	no	no	no	no	no	K/C/O Bronchial asthma with ABPA with superadded infection
27	O. P	11.6	yes	no	no	no	no	no	no	no	no	no	Sequelae of Old pulmonary tuberculosis
28	S. K	12.1	yes	no	no	no	no	no	no	no	no	no	Focal aneurysm Rt middle lobe with Hemorrhage
29	D. S	10.9	no	yes ; pt undervent VATS lobectomy	no	no	no	no	no	no	no	no	Bronchiectasis with acute & chronic bacterial colonisation
30	S . S	11.6	yes	no	no	no	no	no	no	no	no	no	Sequelae of Old pulmonary tuberculosis

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No. BFUHS/2K21p-TH/ 5046 **Date** 20/4/2021

The Principal,
DMC,Ludhiana.

Subject: **Approval of Plan of Thesis.**

This is to inform you that the Faculty of Medical Sciences in its meeting held on 22.01.2021 has approved the plan of thesis of **Dr.Baljit Kaur,** a student of your college for **MD Radio-Diagnosis** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis
Evaluation of radiological findings and outcomes in patients undergoing bronchial artery embolization

Supervisor
Dr. Siddharth Prakash
Assoc. Prof.,
Dept. of Radio-diagnosis,
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Co-Supervisor
Dr. Kamini Gupta
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The student has to submit the three copies of thesis (along with PDF format) , to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She must directed to attach a photocopy of this letter with the forwarding letter while submitting thesis to the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic,(if any).

S.P.Singh

Dr. S P Singh MS(Oph)
Controller of Examinations

Note :

1. ***If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.***
2. *The student may submit the thesis as per the schedule already conveyed i.e for May/June examination 30th Nov of the preceding the year of examination and for Nov/Dec examinations 31st May of the year of examination.*

EVALUATION OF RADIOLOGICAL FINDINGS AND OUTCOMES IN PATIENTS UNDERGOING BRONCHIAL ARTERY EMBOLIZATION

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED IN

PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

Doctor of Medicine

in

RADIODIAGNOSIS

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

NOVEMBER, 2019

DR. BALJIT KAUR

DEPARTMENT OF RADIODIAGNOSIS
DAYANAND MEDICAL COLLEGE AND HOSPITAL
LUDHIANA

ABSTRACT OF PLAN OF THESIS

Title	EVALUATION OF RADIOLOGICAL FINDINGS AND OUTCOMES IN PATIENTS UNDERGOING BRONCHIAL ARTERY EMBOLIZATION
For the degree of	Radiodiagnosis
Name of the candidate	Dr. Baljit Kaur
Supervisor	Dr. Siddharth Prakash, Associate Professor Department of Radiodiagnosis
Co-supervisors	Dr. Kamini Gupta, Professor, Department of Radiodiagnosis, DMCH, Ludhiana Dr. Akashdeep Singh, Professor, Department of Pulmonary Medicine, DMCH, Ludhiana
Institution	Dayanand Medical College & Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: Hemoptysis due to various etiologies, especially if massive, is a life threatening respiratory emergency. Bronchial Artery Embolization (BAE) is a life saving and minimally invasive interventional radiological technique and is first line treatment for massive hemoptysis where surgical interventions are contraindicated as ninety nine percent of massive hemoptysis originates from bronchial arteries rather than pulmonary circulation. Even the most compromised patients can be successfully managed with BAE as first-line treatment for hemorrhage as well as providing a bridge to more definitive medical or non-emergent surgical intervention focused upon the etiology of the hemorrhage.

Aims & Objectives: To evaluate the radiological findings and outcomes in patients undergoing Bronchial Artery Embolisation(BAE).

Materials and methods: This study will be conducted for one and half year from 15th Nov 2019- 15th May 2021 (including followup) in the Department of Radiodiagnosis. The adult patients (>18 years of age) presenting with massive hemoptysis in Dayanand Medical College and Hospital, Ludhiana will be investigated by chest x rays, CT chest/ CT angiography (wherever possible) to look for cause of hemoptysis and referred to interventional radiologist in department of Radiodiagnosis, for Bronchial Artery Embolization are included. The demographic profile, etiology of massive hemoptysis, duration of underlying disease, pre procedure radiological findings and post-procedure follow up will be recorded as per designed proforma.

Clinical significance: To correlate radiological findings with amount of hemoptysis. To assess whether certain radiological patterns/distribution may predict the outcome(success/failure) of BAE.

Keywords: Hemoptysis, Bronchial artery embolization, Intervention, CT Angiography, Radiology.

(signature)	(signature)	(signature)	(signature)	(signature)
Candidate	Co Supervisor	Co Supervisor	Supervisor	Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"EVALUATION OF RADIOLOGICAL FINDINGS AND OUTCOMES IN PATIENTS UNDERGOING BRONCHIAL ARTERY EMBOLIZATION"** exist in the Department of Radiodiagnosis, DMC&H, Ludhiana and will be provided to the candidate. We will see that the data being included in the thesis is genuine and is collected by the candidate herself under our supervision and guidance.

Supervisor

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Date: _____

APPROVAL PROFORMA
BY
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Name of candidate	Dr. Baljit Kaur
Department	Radiodiagnosis
Topic of Thesis	EVALUATION OF RADIOLOGICAL FINDINGS AND OUTCOMES IN PATIENTS UNDERGOING BRONCHIAL ARTERY EMBOLIZATION
Likely date of appearing in PG examination	May-June 2022
Date of enrollment	1st May 2019
Name of Head of Department	Dr. Kavita Saggar
1) Supervisor **2) Co-Supervisor(s)**	Dr. Siddharth Prakash Dr. Kamini Gupta Dr. Akashdeep Singh
Signature of Members of Research Committee with Stamp	**Signature of Members of Ethics Committee with Stamp**
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Dr. Dinesh Gupta (Professor & Head, Medicine)	Dr. Anu Sharma (Professor, Anatomy)
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	Dr. Gagandeep Singh (Secretary, Ethics Committee Professor & Head, Neurology)

Approved: Yes / ~~No~~

Dr. Sandeep Puri
Chairperson
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Approved: Yes / ~~No~~

Prof. Arvind Malhotra
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Chairperson
Ethics Committee

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

1	NAME OF THE CANDIDATE AND ADDRESS	Dr. Baljit Kaur ,R/o B-10/359, Dr. Ambekar Nagar, Nawanshahar ,(S.B.S.Nagar), Punjab,PIN 144514
2	NAME OF THE INSTITUTE	Dayanand Medical College and Hospital, Ludhiana
3	COURSE OF STUDY AND SUBJECT	M.D. Radiodiagnosis
4	DATE OF ADMISSION OF COURSE	01/05/2019
5	TITLE OF THE TOPIC	EVALUATION OF RADIOLOGICAL FINDINGS AND OUTCOMES IN PATIENTS UNDERGOING BRONCHIAL ARTERY EMBOLIZATION

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Haemoptysis is a life threatening respiratory emergency due to various etiologies such as bronchiectasis (both tubercular and nontubercular), fungal infections (aspergilloma), cystic fibrosis, Arteriovenous malformations and neoplasms etc. BAE is life saving and minimally invasive interventional radiological technique. It was first performed in 1973 by Remy et al, and has become a widely accepted treatment option in the management of patients with haemoptysis. Haemoptysis occurs by similar mechanisms in benign and malignant etiologies, that is, by local necrosis and inflammation of blood vessels.[1,2] Angiography and bronchial artery embolization (BAE) are important modalities allowing for rapid diagnosis and treatment in hemoptysis.[3] BAE is first line treatment for massive hemoptysis where surgical interventions are contraindicated as Ninety percent of massive hemoptysis originates from the bronchial arteries rather than the pulmonary circulation (5%).[4] Conservative management of massive hemoptysis carries a broad mortality range of 50-100%.[5] This study will be conducted for the evaluation of the radiological findings and outcomes in patients undergoing bronchial artery embolization. Etiological causes are usually investigated with chest radiography, and computed tomography (CT) for underlying lung parenchymal abnormalities. CT has proven to be of considerable diagnostic value in diagnosing underlying disease, which alone can localize the site of bleeding in 63–100% of patients.[6,7] In India tuberculosis being the most common cause leading to bronchiectasis which causes erosion of bronchial artery leading to hemoptysis.[8] Etiological causes cannot be identified in 7%–22% of cases, and the condition is defined as cryptogenic hemoptysis.[9] BAE is an effective and reliable treatment option for cryptogenic hemoptysis, with excellent short-term and long-term results.[10]

The aim of embolization is to reduce the perfusion pressure to fragile vessels in affected areas of lung by occluding the systemic arterial inflow. It is important to embolize as close to the site of the abnormal

bronchopulmonary anastomoses as possible, in order to prevent their recurrence from nonbronchial systemic collateral vessels. A number of embolic materials are available for BAE for example Gel foam, glue (nbutyl-2-cyanoacrylate), PVA (Polyvinyl Alcohol). PVA is nonabsorbable particulate agent available in a variety of particulate sizes, with 355 to 500 micrometer in diameter particles the most frequently used worldwide.[11] Metal coils are generally avoided because they tend to occlude more proximal vessels and preclude further embolization if bleeding recurs.[12] However, they are used to occlude pulmonary artery aneurysms and pulmonary Arteriovenous Malformations.

Post procedure complications such as Recurrence, Chest pain and dysphagia commonly occur with selective (versus super selective) embolisation within the first week following the procedure. These symptoms are secondary to the interruption of the blood supply to the posterior mediastinum and mid-portion of the oesophagus. This is less common when distal super selective catheterisation is used.[13-15] Recurrence of hemoptysis Is common, especially in patients with chronic pulmonary aspergillosis (CPA). Cavitating lung lesions, nonbronchial systemic artery collaterals and systemic-to-pulmonary venous shunts appeared more commonly among patients who had recurrence of hemoptysis Definitive treatment for CPA following successful BAE should be considered to ensure the long-term success of the embolization in these patients.[16]

Few rare complications include Spinal cord injury, subintimal dissection of the aorta, transverse myelitis [17] and anterior cord syndrome. With the current use of non-ionic contrast media, particulate embolic agents greater than 200 mm and modern microcatheters or microguidewires, nontarget embolisation should be quite rare

6.2 REVIEW OF LITERATURE

Anuradha et al [18] evaluated the results of BAE in 58 patients with post-TB sequelae. 58 patients underwent 64 bronchial artery embolizations for massive hemoptysis due to tuberculosis 25 patients presented with acute massive hemoptysis and 33 presented with chronic recurrent hemoptysis. The median follow-up period was 432 days. Twenty-seven patients had recurrence

after a median period of 110 days after the procedure. The hemoptysis control rate was 93% at 2 weeks, 86% at one month, 79.5% at 3 months, 63% at6 months. Six patients underwent repeat procedures. Chest pain was the most common procedure-related complication (n=20, 34.5%); there was no spinal cord complication or mortality. Lung cavities, nonbronchial systemic artery collaterals and systemicto-pulmonary venous shunts were more common in those who experienced recurrence. Post-procedure complications: chest pain in 20 (34.5%), dysphagia in 3 (5%), transient dissection of bronchial and intercostalsarteriesin 2 (3.4%) patients.

Mishra et al [19] evaluated 52 patients with hemoptysis and had a median follow up of 35 days. He showed Tuberculosis and its sequel (bronchiectasis and chronic fibrotic changes) as the commonest etiology (65%). The BAE showed high short term efficacy (92%) in stopping the hemoptysis with a relatively low complication rate especially of major complications such as spinal cord ischemia (1.9%). BAE should be tried in all patients presenting with uncontrollable or massive hemoptysis not getting relief by conservative management alone.

Tanaka and colleagues[20] selected 47 patients with hemoptysis. Superselective embolotherapy was performed using a microcatheter inserted into the bronchial artery beyond the spinal or mediastinal branches in 22 patients. In the remaining 25 patients, non-superselective embolization was performed ,near the origin of the bronchial artery. There were no significant differences between the two

groups in the initial or cumulative control of hemoptysis. There were no neurologic complications in the superselective group

Ramakantan et al [21] evaluated the results of BAE in 140 patients with tuberculosis and documented postprocedure complications in 12 patients, including transient paraparesis in 2 patients, transient dysphagia in 1 patient, and transient left orbital/forehead pain in 9 patients.

Prasad et al [8] in their study observed tuberculosis as the leading cause of haemoptysis seen in 79.2% of patients and the majority of patients had moderate haemoptysis.

Mal et al, [22] reported that among 56 patients undergoing attempted embolization procedures for hemoptysis, the immediate control of bleeding was achieved in 43 of 56 patients (77%).

Rabkin et al, [23] evaluated 306 patients and found that BAE controlled acute bleeding in 278 (91%).

Cremaschi et al [24] evaluated 209 patients who had been embolized for hemoptysis and noted that immediate control was achieved after BAE in 205 (98%).

Brinson et al. [25] in regards to cystic fibrosis, published the most comprehensive review to date by evaluating 18 patients who underwent a total of 36 BAE procedures. The overall efficacy of the BAE for initial control of hemoptysis was 75% after one session.

Peter Corr et al [26], embolization of bronchial and systemic arteries is an effective method for treating acute severe hemoptysis from intracavitary aspergillomas, allowing the patient time to recover for definitive surgical management

Hayakawa et al [27] have reported two peak times of bleeding recurrence. The first is from 1 to 2 months after BAE, which may reflect incomplete embolization. The second peak for recurrence is from 1 to 2 years after the patient underwent embolization. This appears to reflect the recruitment of blood supply and revascularization due to underlying pulmonary inflammation or progression of the underlying disease

Saluja et al [12] have suggested that coils should not be used for BAE as they cause proximal occlusion and do not allow for repeat embolization if necessary.

Singhal et al [14] also reported aspergilloma as the cause of recurrence of haemoptysis in one patient during their one-year followup. Thus, aspergilloma remains the commonest cause of recurrence of haemoptysis after embolisation and requires repeated embolisation or definitive surgical management.

Shin B, Koh W-J, Shin SW, Jeong B-H, Park HY, Suh GY, et al. (2016) [16] BAE is a safe and effective procedure for the management of life-threatening hemoptysis in patients with CPA. However, recurrence of hemoptysis was common, especially in patients with CPA. Therefore, definitive treatment for CPA following successful BAE should be considered to ensure the long-term success of the embolization in these patients.

Kervancioglu S, et al (2015) [10] Angiographic findings show that whatever the underlying cause for cryptogenic hemoptysis, it involves the lung(s) in a diffuse manner. BAE is an effective and reliable treatment option for cryptogenic hemoptysis, with excellent short-term and long-term results.

Hirshberg et al [28] studied the etiology, evaluation, and outcome of 208 patients with hemoptysis in a tertiary referral hospital. They found that the most common causes of hemoptysis included bronchiectasis (20%), lung cancer (19%), bronchitis (18%), and pneumonia (16%).

Knott-Craig and colleagues [29] retrospectively studied 120 patients with hemoptysis and found that the right lung was the source in 62% and the left lung in 38%, with the right upper lobe being the area that was most commonly affected.

Lee et al. [30] demonstrated a significant association between active tuberculosis and recurrence after BAE.

6.3 AIMS AND OBJECTIVES

To evaluate the radiological findings and outcomes in patients undergoing Bronchial Artery Embolisation(BAE)

7. MATERIALS AND METHODS

This case series analysis will be conducted in the Department of Radiodiagnosis, Dayanand Medical College and Hospital, Ludhiana, Punjab for one and half years from 15th Nov. 2019- 15th May 2021 (including followup). The adult patients (>18 years of age) presenting with massive hemoptysis in DMCH Ludhiana and will be investigated by chest x rays, CT chest and CT angiography(wherever possible) to look for cause of hemoptysis and referred to interventional radiologist in department of radiodiagnosis, for Bronchial Artery Embolization are included. The demographic profile, etiology of massive hemoptysis, duration of underlying disease, pre procedure radiological findings and post-procedure follow up will be recorded as per designed proforma.

7.1 Source of Data

The study will be conducted on patients who underwent BAE in IR department of department of radiodiagnosis, DMCH Ludhiana. Their preprocedural radiological investigations during this time frame will be studied and follow up will be done to know clinical outcomes, etiology of hemoptysis (if possible) and post procedure complications of patients after BAE.

7.2 METHOD OF COLLECTION OF DATA

This case series analysis will be conducted in the Department of Radiodiagnosis, Dayanand Medical College and Hospital, Ludhiana, Punjab for one and half years from 15th Nov. 2019- 15th May 2021 (including followup). The adult patients (>18 years of age) presenting with massive hemoptysis in DMCH Ludhiana and will be investigated by chest x rays, CT chest and CT angiography to look for cause of hemoptysis and referred to interventional radiologist in department of radiodiagnosis,for Bronchial Artery Embolization are included. The demographic profile, etiology of massive hemoptysis, duration of underlying disease, pre procedure radiological findings and post-procedure follow up will be recorded as per designed proforma. Details of past medical history, age, will be taken into consideration during follow up.

Inclusion criteria: Hemoptysis

Exclusion Criteria:

1. Consent not available
2. Contrast allergy
3. Coagulation disorder.
4. Diffuse alveolar hemorrhage.
5. Vasculitis

Duration of study: One and half years from 15th Nov. 2019- 15th May 2021 (including followup)

Outcome: Immediate and late (3 month) outcome/success of BAE.

Statistical analysis: Data will be described in terms of range; mean ±standard deviation (± SD), frequencies (number of cases) and relative frequencies (percentages) as appropriate. All statistical calculations will be done using SPSS (Statistical Package for the Social Science) SPSS 21 version statistical program for Microsoft Windows.

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

No

7.4 HAS ETHICAL CLEARANCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Attached herewith

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PROFORMA

Sr. No-

NAME -

AGE -

ADDRESS -

PH NO -

MRD NO -

CONSULTANT

DATE OF PROCEDURE –

INDICATION -

Hemoptysis –

Duration

Amount

Mild-(5 to 10 cc)

Massive >200 ml

If massive – hemodynamic status – BP/HR

Intubation Required – Yes/No

Any other indication –

History of TB, Bronchiectasis, Lung Abscess, Mycetoma, Cavitary Lung Infection, Necrotizing pneumonia, Bronchial Adenoma, AV malformation, Bronchial artery aneurysm, Chronic pulmonary interstitial fibrosis, Pulmonary contusion and trauma , Pulmonary embolism or infarction, Septic pulmonary embolism , others.

Treatment taken

- Duration of treatment
- If ATT
  - Regimen of ATT

Pre procedure work up : HB –

TLC –

CREATININE –

PT/INR –

ANA/ANCA profile (if any)

Sputum analysis

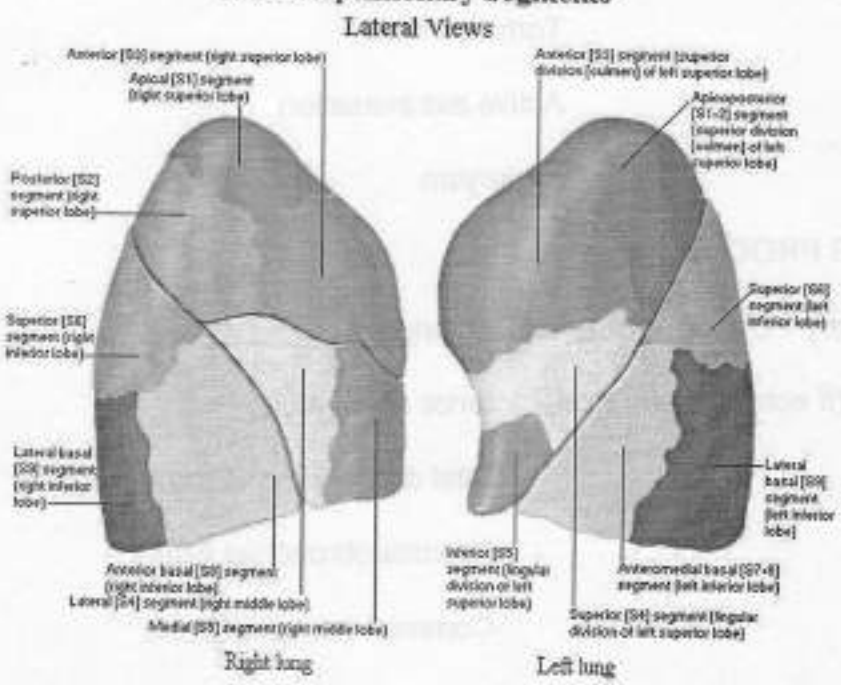
- Gram stain
- Culture/Sensitivity
- CBNAAT

Pre procedure investigation –

Chest X ray –

Lung zone	Consolidation	Reticulonodular	Milliary pattern	Fibrocystic	Ground Glass Haze	Nodule/ mass
Rt.upper						
Rt.middle						
Rt.lower						
Lt.upper						
Lt.miidle						
Lt.lower						

CT– Findings; PARENCHYMAL


Bronchopulmonary Segments
Lateral Views
Anterior [S3] segment (right superior lobe)
Apical [S1] segment (right superior lobe)
Posterior [S2] segment (right superior lobe)
Superior [S6] segment (right inferior lobe)
Lateral basal [S9] segment (right inferior lobe)
Anterior basal [S8] segment (right inferior lobe)
Lateral [S4] segment (right middle lobe)
Medial [S5] segment (right middle lobe)
Right lung
Anterior [S3] segment (superior division (culmen) of left superior lobe)
Superior [S6] segment (left inferior lobe)
Lateral basal [S9] segment (left inferior lobe)
Inferior [S5] segment (lingular division of left superior lobe)
Superior [S4] segment (lingular division of left superior lobe)
Left lung

Lung lobe	Segment	Consolidation	Cavity	Bronchiectasis	Milliary pattern	Fibrocystic/ Fibronodular/ Aspergillosis	DAH/ DAD	Mediastinal lymph node
Rt.upper	Apical							
	Posterior							
	Anterior							
Rt.middle	Lateral							
	Medial							
Rt.lower	Superior							
	Medial							
	Anterior							
	Lateral							
	Posterior							
Lt.upper	Apicopost							
	Anterior							
	Sup.lingular							
	Inf.lingular							
Lt.lower	Superior							
	Anteromedial							
	Lateral							
	Posterior							

VASCULAR-

Any Hypertrophy of artery

Tortuous artery

Active extravasation

Aneurysm

- CATH LAB PROCRDURE –

Was artery - Orthoptic or Ectopic in origin

(If ectopic from- Aorta: inferior aortic arch

distal descending thoracic aorta

-Intercostobronchial Artery

-Common bronchial trunk

Others: extrabronchial- internal mammary artery

Intercostal artery

Subclavian artery

Lateral thoracic artery

Thyrocervical trunk

Brachiocephalic trunk

Coronary artery)

Was Artery - Hypertrophied

- Torturous
- Active extravasation
- Aneurysm

Was there arterio – pulmonary shunting

Artery embolized- Bronchial artery(R/L)

Intercostals arteries (R/L)

Internal mammary artery

Any other branch from subclavian

- Was done with - Gel foam

-Pva

- Was microcatheter used-

- FOLLOW UP NEXT DAY –

Chest XRay

Intubation status

Hemodynamic status – BP/PR

- POST PROCEDURE –

Any hemoptysis

HB –

Any other outcome – Hemostasis achieved

Recurrence of hemoptysis (during 0,1,3 month follow up)

Chest pain

Dysphagia

Intervention site hematoma

Vascular

Pulmonary

Sepsis

Contrast Nephropathy

Neurological

INFORMED PATIENT CONSENT

Date: _____

I.....D/o, W/o, S/o..... .....am willing to participate in the study **"EVALUATION OF RADIOLOGICAL FINDINGS AND OUTCOMES IN PATIENTS UNDERGOING BRONCHIAL ARTERY EMBOLIZATION"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

....

Signature of the Witness Signature of the patient

Name:

Signature of Candidate **Signature of Supervisor**

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____ निवासी _____ इस शोधकार्य "**EVALUATION OF RADIOLOGICAL FINDINGS AND OUTCOMES IN PATIENTS UNDERGOING BRONCHIAL ARTERY EMBOLIZATION**" में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____
गवाह के हस्ताक्षर
नाम:

_____
रोगी के हस्ताक्षर/अंगूठे का निशान
नाम:

_____
अन्वेषक के हस्ताक्षर

_____
विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____

"EVALUATION OF RADIOLOGICAL FINDINGS AND OUTCOMES IN PATIENTS UNDERGOING BRONCHIAL ARTERY EMBOLIZATION" ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

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ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

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ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

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ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ